

SE463 / CS445 / CS645 / ECE451**Fall 2013 — Final Exam**

5 December 2013, 12:30pm–3:00pm

Instructor: Daniel M. Berry

Time allowed: 2.5 hours = 150 minutes

No aids allowed (*i.e.*, closed book).

Answer all of the questions on this exam paper.

There are 8 questions for a total of 150 marks.

Plan your time wisely: 1 minute per mark

Your Name and Student Number

In the immortal words of the yet to be born Jean Luc Picard of Earth,

<i>Make it so!</i>

Q1		/ 25
Q2		/ 40
Q3		/ 15
Q4		/ 20
Q5		/ 5
Q6		/ 20
Q7		/ 20
Q8		/ 5
TOTAL		/150

In this exam, a short underscore of 1 inch (= 2.54 cm) should be filled with one word. A long underscore of 3 inches (= 7.63 cm) should be filled with a phrase consisting of one to several words. In the former case, if you cannot think of exactly the right number of words, then give the best answer that you can and we'll give it as many marks as we can, possibly even full credit! If you cannot even think of words to fill in, then write an answer as a sentence, and we'll give it as many marks as we can.

In this exam, in a **True** or **False** item, each correct answer is worth the stated number of marks; each incorrect answer is worth the negative of one half of the stated number of marks, unless the item asks for an explanation as well. So, it is generally not worth guessing on **True** or **False** items.

1. [25 total marks] Short Answer, Many Fill-in-the-Blanks, Some **True-or-False**

In the validation condition, $D, S \vdash R$ for a system under development, D describes

_____, S describes

_____, and R describes

_____. There is lots of uncertainty in D and R because they

are about the real _____. Even though a program can be thought of as a man-made, formal, mathematical artifact, there is some uncertainty even in S . For example, the expression " $x * (1.0/x) == 1.0$ " occurring in S is not always true. Explain why.

In $D, S \vdash R$ about a traffic light, suggest concrete changes to S , about the behavior of the traffic light system itself, that allow removing the assumptions

(1) that drivers obey the law and

(2) that cars function correctly

from D while still meeting R , which says that cars going in perpendicular directions do not collide.

What two questions must be asked of a client whenever a natural-language scenario step from the client is of the form, “If all goes well, display ‘AOK’ on the screen.”

1.

2.

Quality–Function Deployment (QFD) is so named because a QFD matrix _____ qualities to _____ .

Suppose that in a QFD matrix, the nonfunctional requirement N is mapped positively to functional requirements $R1, \dots Rn$. QFD’s basic premise is that the stakeholders agree that if

_____ then N is regarded as having been satisfied.

Explain why the nonfunctional requirement “performance” may conflict with the nonfunctional requirement “reusability”.

Explain why the nonfunctional requirement “performance” may conflict with the nonfunctional requirement “security”.

Give two reasons that “We don’t have enough time to finish the requirements. We have to start coding to finish in time!” is a myth.

1.

2.

Why is it necessary for Donald Knuth’s *T_EXbook*, the user’s manual for T_EX, to show the line-breaking algorithm, which is normally an implementation detail and is not discussed at all in user’s manuals for other formatters such as troff and Microsoft Word?

Why is it necessary for a domain model and a user’s manual for the bidirectional word processor you described in your deliverables to expose the existence of the logically ordered (a.k.a. time-ordered) internal edited file and its relationship to the visually ordered display?

What simple operation that is already done in most computer systems would make so-called permanent deletion of files from recycle bin undoable?

If a customer offers you $\$X$ to build system S , in normal circumstances, you will not take the job to build S unless you can be sufficiently certain that _____ .

You might say that any technology T that appears to be a silver bullet is a silver bullet for only a short while. It quickly becomes a _____ bullet almost overnight (an exaggeration to be sure), as soon as we solve with the help of T all _____ that were too hard to solve without T . The remaining _____ are even _____ to solve.

An important part of the job of an inspection meeting moderator is to stop attempts by the participants to _____ the defects that have been reported and to _____ about whether a reported defect is indeed a defect.

In a building that must have at least one kosher kitchen, the separation of dairy and meat food must be either temporal or _____. That is, in one kitchen, dairy and meat food cannot be in preparation at the _____ time. However, if the building has separate _____ and _____ kitchens, then it is permissible to prepare _____ and _____ food at the _____ time.

There is some evidence that the business model of many in the house building industry is that the contractors for constructing the house from plans _____ the price to win the contract. Such a contractor is counting on the customer finding needed _____ to the plans during construction. When these are found, the contractor charges _____ for them to ensure that he or she gets a _____.

2. [40 total marks] Domain and Use Case Modeling in Ignorance

Recall the class model that was made from the sentence “The thingamajig snarkles the doodad.” in ignorance of what some of the words in the sentence mean.

Consider the following refinement of this information about thingamajigs.

- (a) Each thingamajig snarkles exactly two doodads.
- (b) Each thingamajig is a thingamabob, but only an occasional thingamabob is a thingamajig.
- (c) Each thingamabob snuffles exactly one doohicky.
- (d) Each doodad has a whatnot doing the basic diddling part of snarkeling.
- (e) Each doohicky has a whatnot doing the basic diddling part of snuffling.
- (f) Initially, each doodad is mommed.
- (g) Initially, each doohicky is hicked.
- (h) As a result of snarkling, a doodad becomes jigged.
- (i) As a result of snuffling, a doohicky becomes bobbed.
- (j) No thingamajig knows anything about whatnots.
- (k) No thingamabob knows anything about whatnots.

Assume that these sentences describe the entire domain.

On the next page, draw a domain model of this thingamajig domain in the form of a UML class diagram with a superimposed world diagram that divides the world into the environment, the system, and thus the shared interface. Be sure to show

- (a) attributes and methods, i.e., procedures, in each class that needs any,
- (b) “<<actor>>” stereotypes where they are needed,
- (c) a multiplicity at each end of any arc connecting a pair of classes, and
- (d) each necessary inheritance.

When you are finished making the domain model, please add dotted arcs that show all implicit accesses that happen by virtue of the explicit accesses combined with any inheritance. Put a multiplicity at each end of each dotted arc.

In the rest of this page draw a use case model of the thingajig domain, on the assumption that the actors of the diagram include “thingamajig” and only everything else that *must* be an actor according to the domain description. Please, show only the use case model and nothing of any scenario.

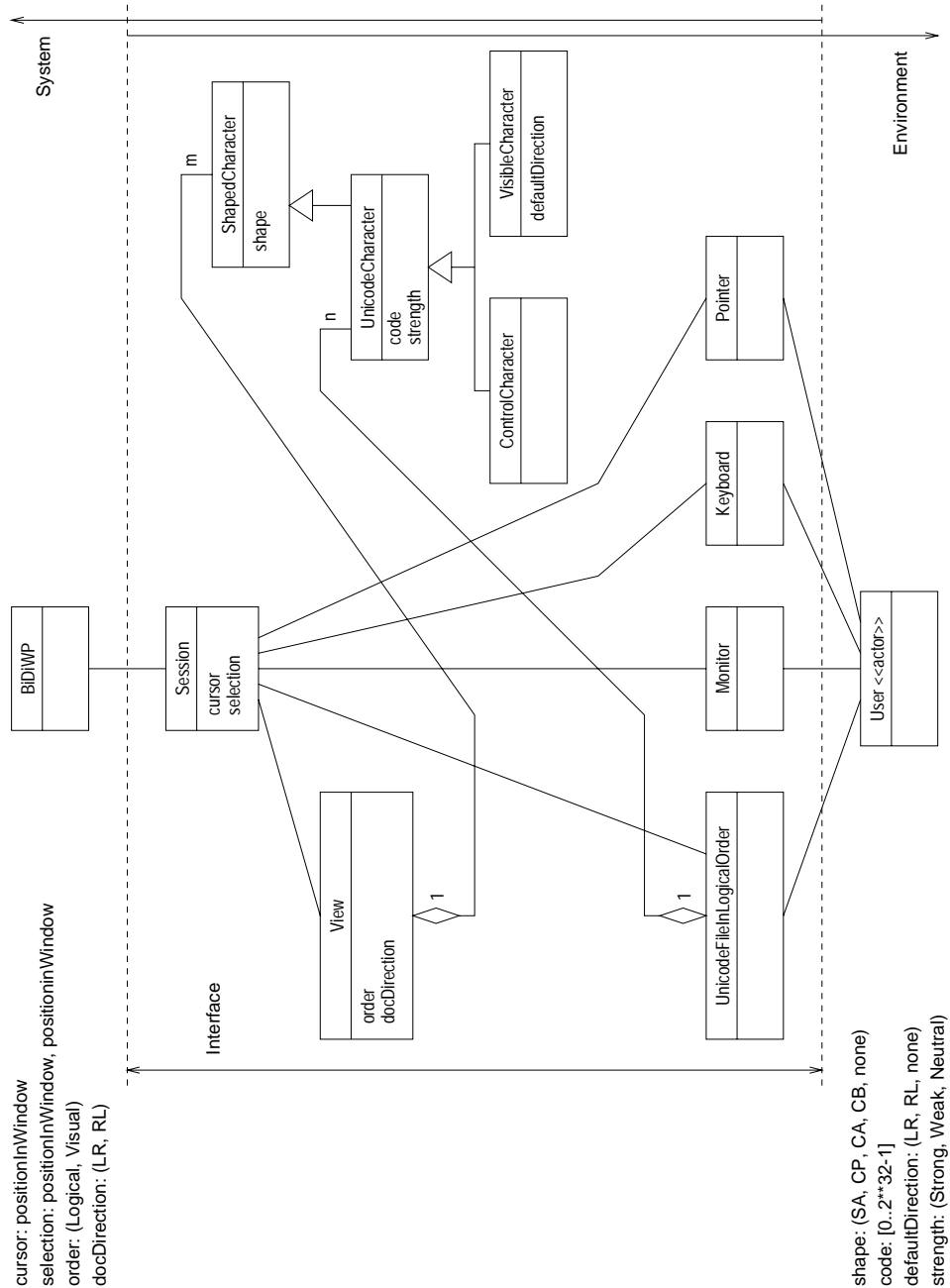
Note that there is still another question.

On your use case model above, please add dotted arcs that show all implicit accesses that happen by virtue of the explicit accesses combined with any inheritance.

What advantage might your models have over those produced by someone who is an expert about thingamajigs?

3. [15 total marks] Variations of the Project's Domain and Use Case Models

Please see below the domain model of the bidirectional word processor (BDWP) that was produced as Berry's solution to Deliverable 2.



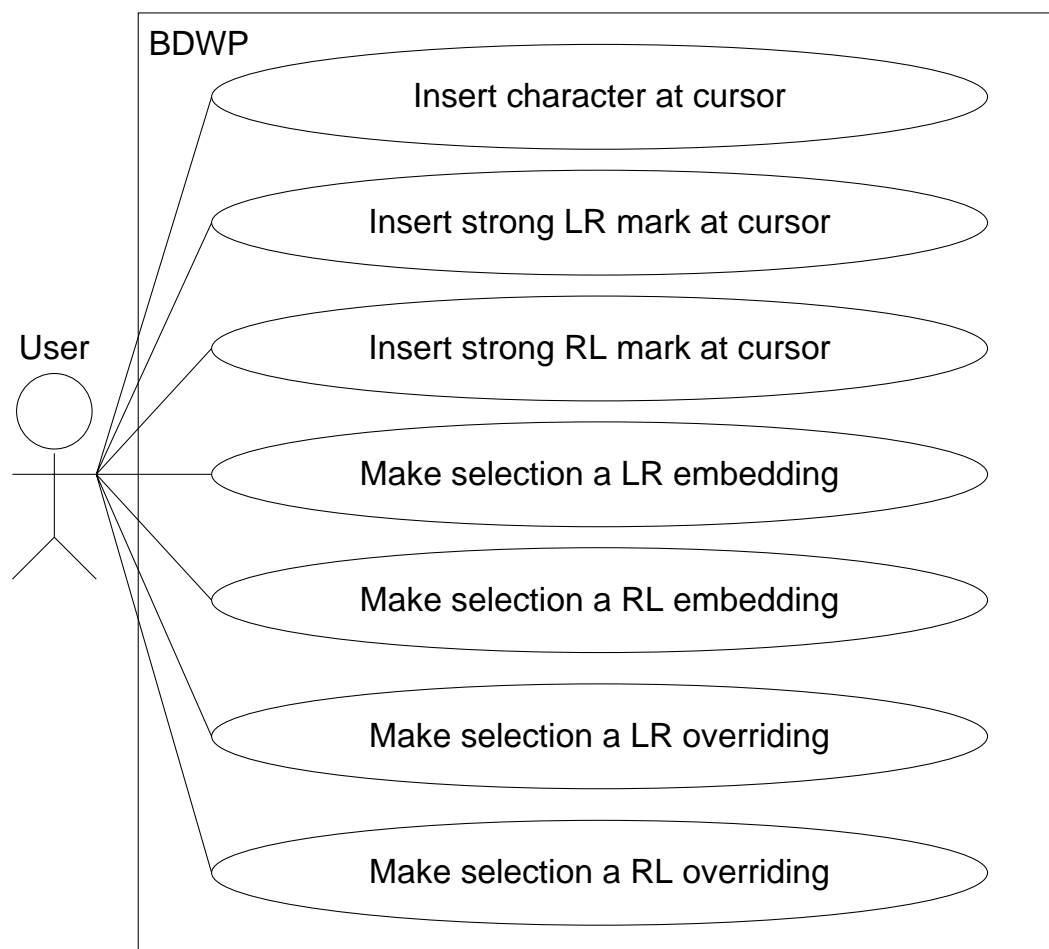
Turn this domain model for a BDWP into a domain model for a unidirectional word processor (UDWP). It has no need for the Unicode Bidirectional Algorithm, embedding, either explicit or implicit, and overriding.

Moreover, the visual ordering of characters is equal to the logical ordering of characters. However, it does need the ability to break up ligatures e.g., for “**fi**” to get “**f**” and “**i**”. (Look carefully to see the difference!) In any case, a ligature shows up only in the displayed view and no ligature is stored in the internal file. Instead, the internal file contains the constituent letters of each ligature. For example, the internal form for a displayed “**fi**” is “**f**” and “**i**”.

You may either modify this diagram or draw a completely new diagram on the rest of this page. Note that there are some additional questions after this one.

If you included any text files, i.e., something akin to the logically ordered file in the BDWP domain model, in the interface part of the world, explain why. Alternatively, if you did not, explain why. (The question is phrased this way to avoid giving away the correct answer.)

Please see below the use case model of the BDWP that was produced as Berry's solution to Deliverable 3.



Turn this use case model for a BDWP into a use case model for the UDWP described above. Do not put in any use cases that are not needed, and add any new ones that *are* needed.

You may either modify this diagram or draw a completely new diagram on the next, blank page.

4. [20 total marks] State Machine Modeling

One of the things that the Unicode Bidirectional Algorithm (UBDA) specifies is the determination of the strength of each character. One particularly interesting part of this determination is the determination of the strength of the punctuation characters, the period (“.”) and the comma (“;”), which can appear both as part of numerals (what the UBDA calls a European Number) and as punctuation among letters. A period or comma that is part of a numeral is weak and a period or comma that is not part of a numeral, and is thus punctuation, is neutral.

You are going to complete an incomplete description of a state machine. If this state machine were expressed as a traditional diagram with nodes and transition arcs, it would be a mess. It has 6 states and there is at least one transition arc between almost every pair of states, including transitions between a state and itself. Therefore, a tabular specification will be used instead.

Each transition is of the form:

“type(c) / output (pc) at some strength; $pc \leftarrow c$ ”

or

“type(c) / output (pc) at some strength”

Here,

- (a) “type” determines the category of its parameter c ,
- (b) c is the current input character,
- (c) pc is the previous input character,
- (d) $pc \leftarrow c$ saves the current character as the previous character, and
- (e) not all transitions need to save the current character as the previous character.

One cannot decide whether a period or comma is part of a numeral until the character after the period or comma has been examined and it has been ascertained that the period or comma is surrounded by digits. Therefore, the state machine does not output a character and announce its strength until one transition after the one that read it. So the state machine must save the current character as the previous character in every transition, except the last transition to the final state. The name of a typical state encodes the possible strengths of the previous character.

current state	c is of type:	pc is output in strength:	$pc \leftarrow c$ is done?	next state
Initial	Letter	not done	done	PCS
	Digit	not done	done	PCW
	Space or Tab	not done	done	PCN
	Period or Comma	not done	done	PCN
	EndOfFile	not done	not done	Final
PCS (previous character is strong)	Letter	Strong	done	PCS
	Digit	Strong	done	PCW
	Space or Tab	Strong	done	PCN
	Period or Comma	Strong	done	PCN
	EndOfFile	Strong	not done	Final
PCN (previous character is neutral)	Letter	Neutral	done	PCS
	Digit	Neutral	done	PCW
	Space or Tab	Neutral	done	PCN
	Period or Comma	Neutral	done	PCN
	EndOfFile	Neutral	not done	Final
PCW (previous character is weak)	Letter	Weak	done	
	Digit	Weak	done	
	Space or Tab	Weak	done	
	Period or Comma	Weak	done	
	EndOfFile	Weak	not done	
PCWN (previous character is weak or neutral)	Letter		done	
	Digit		done	
	Space or Tab		done	
	Period or Comma		done	
	EndOfFile		not done	

The just completed state machine insists that a period or comma that is part of a numeral be surrounded on both sides by a digit. To allow one or more period or commas in a row within a numeral, only the transitions from the state PCWN have to be changed. Make in the abbreviated table below this required change.

current state	c is of type:	pc is output in strength:	$pc \leftarrow c$ is done?	next state
PCWN (previous character is weak or neutral)	Letter		done	
	Digit		done	
	Space or Tab		done	
	Period or Comma		done	
	EndOfFile		not done	

5. [5 total marks] Linear Temporal Logic

Below each temporal logic formula, write out its meaning in words.

(a) $(x==0 \wedge \text{"x" += 3;} \Rightarrow \bigcirc (x==3))$

(b) $(\text{youWinALottery} \Rightarrow \Box \text{youAreVeryRich})$

(c) $(\text{aPersonIsBorn} \Rightarrow (\text{thePersonIsAlive} \mathcal{U} \text{thePersonIsDead}))$

(d) $(\text{aMessageIsSent} \Rightarrow \Diamond \text{theMessageIsReceived})$

(e) $\Box (\text{aMessageIsSent} \Rightarrow \Diamond \text{theMessageIsReceived})$

(If you use neither “if” nor any of “henceforth”, “always”, “forever”, and “permanently”, and you are correct, then you will get an extra point.)

- (f) $(\text{aLecture starts} \Rightarrow (\text{theLectureIsBoring} \Rightarrow (\text{theLecturingContinues} \mathcal{W} \text{theLectureEnds})))$
 \wedge
 $(\text{theLectureIsExciting} \Rightarrow (\text{theLecturingContinues} \mathcal{U} \text{theLectureEnds})))$

(g) In formula (f), if aLectureStarts and theLectureIsBoring, is it guaranteed that $\Diamond \text{theLectureEnds}$?

(h) In formula (f), if aLectureStarts and theLectureIsExciting, is it guaranteed that $\Diamond \text{theLectureEnds}$?

(i) In formula (f), if aLectureStarts and theLectureIsBoring, is it possible that $\Box \text{theLecturingContinues}$?

(j) In formula (f), if aLectureStarts and theLectureIsExciting, is it possible that $\Box \text{theLecturingContinues}$?

6. [20 total marks] Ambiguity and Writing Style

There is no way to _____ natural language and thus ambiguity in requirements specification. Therefore, whenever a requirement analyst finds an ambiguity in a problem description, he or she must _____ the author of the description what he or she _____ .

Subconscious _____ , which strikes during writing or speaking, is the flip side of subconscious _____ , which strikes during reading or hearing. These phenomena are called “subconscious” because they happen _____ .

Why is the ambiguity of natural language less of a problem in face-to-face conversation than in writing that is read later by lots of anonymous people?

The course notes point out that the “only” ambiguity tends to happen in English as spoken by native English speakers, and it does not tend to happen in French, German, Hebrew, Italian, Portuguese, and Spanish as spoken by their native speakers. List at least two language-error ambiguities that are language independent, i.e., they *do* happen in each language that has the error-prone construct.

Consider the 9 variations of the sentence I ate an apple., obtained by distributing only and also to different places in the sentence and possibly adding a comma.

- _____ 1. Only I ate an apple.
- _____ 2. I only ate an apple.
- _____ 3. I ate only an apple.
- _____ 4. I ate an only apple.
- _____ 5. Also, I ate an apple.
- _____ 6. Also I ate an apple.
- _____ 7. I also ate an apple.
- _____ 8. I ate also an apple.
- _____ 9. I ate an also apple.

Items B through K below are sentences, each of which might interpret, explain, or exemplify the meaning of one of 9 sentences above. Item A is simply the claim that a sentence above is classified as meaningless.

Please, in the underscore next to each sentence S above, write the letter labeling one of the 11 items below that classifies, interprets, explains, or exemplifies S . Each letter appears in the underscores at most once.

- A. Meaningless
- B. Besides playing football, I ate an apple.
- C. There was only one apple on the table to eat.
- D. Joe ate an apple.
- E. None of the others ate an apple.
- F. I smelled an apple.
- G. I did not smell an apple.
- H. I admired an apple.
- I. I did not admire an apple.
- J. I ate an orange as well.
- K. I did not eat an orange as well.

Suppose you are writing a user's manual or an SRS for a program called "X". In such a document, any of the phrases "the program", "the software", and "the system" is a synonym for "X". In order to avoid unnecessary synonymy, only one of those terms should be used throughout the document. Which of the 4 terms, "the program", "the software", "the system", and "X" is the best to use?

What can happen if you choose one of the others instead?

Suppose you are writing a user's manual or an SRS for a program called "X". In such a document, "X" could be used to denote any of the following closely related but 3 distinct concepts:

- "the X program" — as opposed to any other program *Y*,
- "a copy of the X program on a CD", and
- "an invocation of the X program running on your computer".

For clarity, each of these should have a different phrase for it in the document *and* "X" should *not* be used to denote more than one of them. You must choose *one* of these 3 phrases to be replaced by "X" in the document. On the likely assumption that most of any such document describes how the specified software behaves when it is run, which of the 3 phrases

- "the X program",
- "a copy of the X program on a CD", or
- "an invocation of the X program running on your computer",

is best to replace by "X" and thus to use the phrase itself for each of the other phrases?

Why is your choice the best?

7. [20 total marks] Unicode, the Unicode Bidirectional Algorithm, and Bidirectional Word Processing

- (a) Each Arabic, Persian, or Urdu letter has up to _____ forms, but an occasional of these letters has only _____ forms.
- (b) If you do not have a menu or toolbox item for any special character, you do not have a “symbol” or “special character” menu item that brings up a full table of possible insertions, and you do not have a virtual keyboard with control characters, then how may you enter control characters?
- (c) If a user is trying to select in a file f , a region of text that includes a direction change boundary, cognitive dissonance is created by two phenomena:
1. What is contiguous in the _____ view of f is not contiguous in the _____ view of f .
 2. While the hand moving the selecting pointer moves one way, after the direction change boundary is crossed, the highlighted region can _____.
- (d) Connections, i.e., joins, between adjacent characters occur only in _____ alphabets or character sets such as Arabic, Persian, Urdu, and Latin handwriting. Ligatures occur in any alphabet or character set and involve replacing two or more adjacent internal characters by one _____ character. Lam-alif is the most universally used ligature in at least Arabic and Persian.

Give two examples of two-character ligatures that are used in Latin alphabets.

For a bonus point, give a three-character ligature that is used in Latin alphabets.

- (e) Suppose that A and B are characters in a character set in which adjacent letters join. Suppose also that A and B normally form a ligature when they are adjacent and in that order.

If one prevents an occurrence of A followed by B from forming the ligature that they normally form by inserting a zero-width-joiner (ZWJ) in between A and B , then the characters A and B will

_____ .

However, if one prevents an occurrence of A followed by B from forming the ligature that they normally form by inserting a zero-width-non-joiner (ZWNJ) in between A and B , then the characters A and B will

_____ .

- (f) Consider the following sentence LO1 in logical order with the convention that lower case letters are strong L-R characters, upper case letters are strong R-L characters, and the punctuation symbols are themselves.

joe said: hi SHALOM and SALAAM.

Then show the correct visual order representation of LO1:

- (g) Consider the following sentence LO2 in logical order with the convention that lower case letters are strong L-R characters, upper case letters are strong R-L characters, and the punctuation symbols other than “[” and “]” are themselves.

joe said: [hi SHALOM and SALAAM].

Suppose that “[” is RLE and “]” is PDF. Then show the correct visual order representation of LO2:

- (h) Consider the following sentence LO3 in logical order with the convention that lower case letters are strong L-R characters, upper case letters are strong R-L characters, and the punctuation symbols other than “[” and “]” are themselves.

joe said: [hi SHALOM and SALAAM].

Suppose that, in this case, “[” is RLO and “]” is PDF. Then show the correct visual order representation of LO3:

- (i) Consider the following sentence LO4 in logical order with the convention that lower case letters are strong L-R characters, upper case letters are strong R-L characters, and the punctuation symbols other than “[” and “]” are themselves.

joe said: [hi SHALOM and SALAAM.]

Suppose that “[” is RLE and “]” is PDF. Then show the correct visual order representation of LO4:

- (j) Consider the following sentence LO5 in logical order with the convention that lower case letters are strong L-R characters, upper case letters are strong R-L characters, and the punctuation symbols other than “[” and “]” are themselves.

joe said: [hi SHALOM and SALAAM.]

Suppose that, in this case, “[” is RLO and “]” is PDF. Then show the correct visual order representation of LO5:

(k) The set of problems that have been called the “Fundamental Problems of Unicode-Compliant WYSIWYG Bidirectional Word Processors” arise from the facts that

(1) the Unicode Bidirectional Algorithm describes a compliant word processor’s behavior in terms of both

the _____ and the

_____ of the processed file

but

(2) the user of the word processor has to work with _____ the

_____, in which the control characters are

_____.

8. [5 total marks] Graduate Student Lectures

Please answer all of at least three of the questions below. If you answer more, we will give you the points from the highest three. In other words, there is no extra credit for answering more than three.

(a) Lian Yang, “A Case Study: Why the Requirements are Not Written”

What is the basic conundrum of the reason given by the COO for not producing a requirements document before beginning to write code, “No one in the software team sees the whole picture to effectively write the requirements.” Your answer should include another sentence that follows from the COO’s reason, that calls to question the whole development project.

(b) Sri Harsha Boliseti, “Judge Alsup’s Oracle vs Google Decision”

A key test of copyrightability is that if there is only one way to express X , then X cannot be copyrighted. Indicate which of the following artifacts in the first column may be copyrighted and which may not, by checking off the correct of the second or third column.

Artifact	Copyrightable	NOT Copyrightable
The bubble sort algorithm		
The interior code of a procedure to do a bubble sort		
The header of a procedure to do a bubble sort		
A correct street map		
An incorrect street map		

(c) Chaitali Mulay, “HealthCare.gov: a Case Study of a Botched Software Project”

Given the short time that millions of U.S. Citizens have to sign up for health insurance under the Affordable Care Act before the deadline, name the most important nonfunctional requirement that was not being met by the HealthCare.gov Web site.

The developers of the Web site simply did not allow enough time for _____ the site before it was rolled out on schedule on 1 October 2013.

(d) Sudeep Reddy Reletti, "Pearson PowerSchool Software Failure"

The fact that new requirements for PowerSchool were emerging as PowerSchool gained popularity says that Meir Lehmann would classify PowerSchool as a _____ system.

Even though Pearson's developers knew enough to gather new requirements from end users rather than from clients, the developers validated the new requirements with only the _____ .

(e) Venkatesh Vedula, "Jurassic Park, a System Bound to Fail?"

There are at least 3 ways for a safety-critical system to deal with a failure in the system:

1. to fail operationally,
2. to fail safe, and
3. to fail passively.

Which of the three is the most difficult to achieve?

Which of the three is the least difficult to achieve?

On the premise that one should apply the cheapest, simplest method that leaves everyone safe, which of the three should an aircraft apply? and why?

and which of the three should an nuclear power plant apply? and why?

- (f) Ali Niknafs or Daniel Berry, “The Impact of Domain Knowledge on the Effectiveness of Requirements Engineering Activities”

Niknafs conducted controlled experiments to test the hypothesis that a team with a mix of domain aware and domain ignorant generates more requirement ideas in brainstorming than does either a team with only

_____ or with only

_____.

Niknafs found that the data do provide _____ support for this hypothesis.

The nice thing about bidirectional word processor domain for Niknaf’s experiment is that it sharply

_____ the population of potential experimental subjects into

_____ and

_____.