

**SE463 / CS445 / CS645 / ECE451****Fall 2010 — Final exam**

15 December 2010, 12:30pm–3:00pm

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

Plan your time wisely.

Answer all of the questions on this exam paper.

In the immortal words of the late Douglas Adams,

*Don't Panic!*

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|-------|--|-------|
| Q1    |  | / 40  |
| Q2    |  | / 22  |
| Q3    |  | / 8   |
| Q4    |  | / 16  |
| Q5    |  | / 14  |
| Q6    |  | / 10  |
| Q7    |  | / 16  |
| TOTAL |  | / 126 |

## 1. [40 total marks] Short answer

- (a) [2 marks] What is the unofficial three word motto of this course, as mentioned in class many times.  
Hint: The middle word is “not”.
- (b) [3 marks] Suppose for a system  $S$  that there are exactly two concrete actors  $A$  and  $B$ . Each actor may initiate a use case,  $U$ . Further suppose that in a correct and complete use case diagram, there is only one association shown incoming to  $U$ . Explain in words how this diagram situation could be possible, or draw what you mean.
- (c) [2 marks] Give an example of a transient domain object.
- (d) [2 marks] Explain one important difference between strong and weak aggregation.
- (e) [2 marks] Give an example of a process NFR.
- (f) [3 marks] Give an example situation of two non-functional requirements that might cause a conflict if you wanted to optimize them both. Explain why.

- (g) **[2 marks]** Describe one way in which we might measure usability.
- (h) **[3 marks]** With respect to requirements engineering, what is ethnographic analysis? Describe a possible example.
- (i) **[2 marks]** List two kinds of diagrams that are drawn when following the CORAS method, according to Angela Chan.
- (j) **[2 marks]** Based on the lecture by Seid Myadiyev, describe an advantage that paper prototypes have over executable prototypes.
- (k) **[3 marks]** With respect to non-functional requirements, what is a fitness criterion? Give a simple example.

- (l) **[2 marks]** How may the UI of a system be the cause of a disaster in a real-world process run by the system?
- (m) **[2 marks]** What artifacts used in verification and validation of software can have a one-to-one correspondence with scenarios in the sense that one has as complete coverage as the other?
- (n) **[2 marks]** A good UM for a system written before implementing the system should be written so that the reader of the UM \_\_\_\_\_ that the system is already \_\_\_\_\_. In other words, the UM should \_\_\_\_\_ through its teeth (even though it probably does not have teeth).
- (o) **[2 marks]** Adding a programmer to a late project makes it even later because for some number of people in the project, adding one more person who can work 8 hours per day causes more than \_\_\_\_\_ more of \_\_\_\_\_ among the people in the project.
- (p) **[2 marks]** In Michael Jackson's quotation "Requirements engineering is where the informal meets the formal.", the informal is the \_\_\_\_\_'s \_\_\_\_\_, and the formal is the \_\_\_\_\_ and the \_\_\_\_\_.
- (q) **[4 marks]** In the COCOMO formula,  $E = a \times S^b$ , where  $E$  is effort in person months,  $a$  is some constant multiplier,  $S$  is code size in KLOC, and  $b$  is some constant exponent, why is  $b$  greater than 1 rather than less than or equal to 1?

2. [22 total marks] Answer **True** or **False**. Each correct answer is worth 2 marks; each incorrect answer is worth -1, but you cannot get less than zero in total. In the following, “SUD” means “system under development”.

- (a) A primary actor is one who provides services to a use case, responding as needed to a SUD.

**Answer:** \_\_\_\_\_

- (b) When describing the collection of scenarios that make up a use case, it's important to consider possible failure conditions as well as exceptional circumstances that might arise.

**Answer:** \_\_\_\_\_

- (c) In test-driven development, the unit tests are typically written right after the first iteration of coding, so the design is still fresh in the developers' minds.

**Answer:** \_\_\_\_\_

- (d) Uses cases are mostly about modelling the system-level, black box functionality of a SUD; therefore, it is important to concentrate on modelling all of the likely features of the SUD in the use case descriptions.

**Answer:** \_\_\_\_\_

- (e) Waterfall-like processes are well suited to problems with some element of risk or novelty, as they provide good support for changing decisions throughout development.

**Answer:** \_\_\_\_\_

- (f) When specifying a *motherhood* quality attribute, it is important to specify the degree to which the attribute is desired and/or its priority relative to other quality attributes.

**Answer:** \_\_\_\_\_

- (g) According to Tanvir Zahid, a key reason why Facebook succeeded over other social networking sites is that they did a careful job of interviewing users and profiling desired feature sets.

**Answer:** \_\_\_\_\_

- (h) During the first phase of a classical brainstorming session, it's a good idea to emphasize quantity over quality of ideas.

**Answer:** \_\_\_\_\_

- (i) The formula  $D, S \vdash R$  is known also as the *verification condition*.

**Answer:** \_\_\_\_\_

- (j) A scenario may contain many use cases.

**Answer:** \_\_\_\_\_

- (k) A use case may contain many scenarios.

**Answer:** \_\_\_\_\_

3. **[8 total marks]** Domain modelling

A software company has decided to run a curling league for its employees and their spouses. An employee is either a developer or a manager. Each team must consist of four or five players. Each player must be either an employee or the spouse of an employee. The company has a rule that no spouse of an employee may be also an employee. Each team may have at most one manager on the team. Also, the company has decided that there must be at least 4 teams to be able to hold an ongoing league.

Draw a class diagram that models this domain.

4. [16 total marks] State machine modelling, world diagram, and use cases

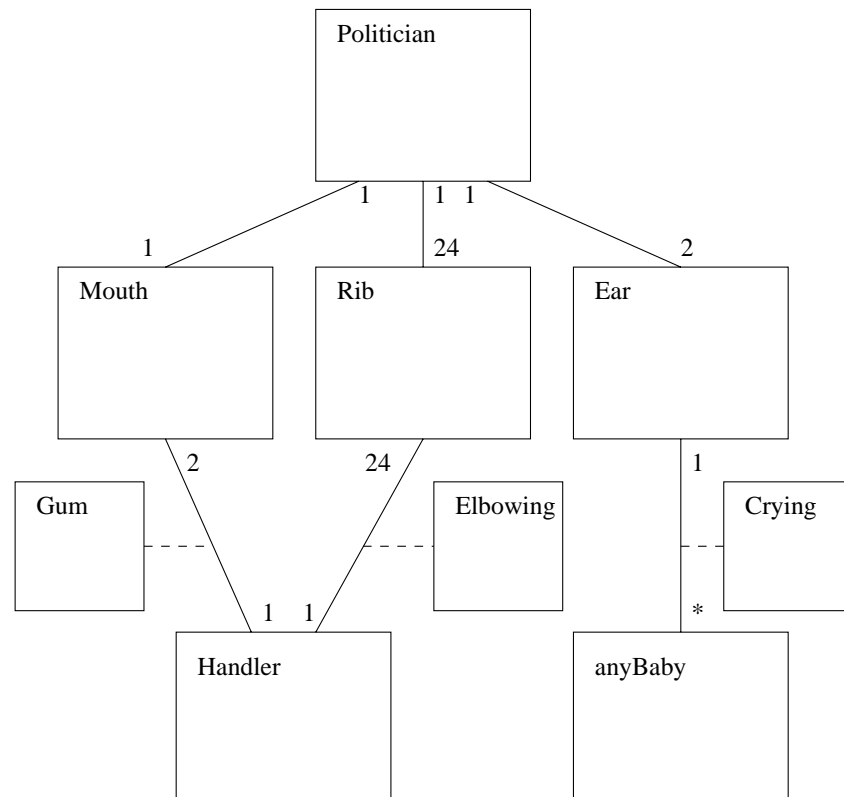
Suppose that you've been hired by the Tyrell Corporation to help build a robot duplicate of a politician, called *P*. Your job will be to create models of *P*'s behaviour to aid in the implementation of the eventual control software.

Lucky for you, *P* doesn't actually do very much; in fact, *P* spends most of his day walking or chewing gum, but not at the same time. *P* doesn't have enough common sense to decide when to switch from one activity to the other, so he is reminded by his *handler H*, who stands next to *P* at all times when in public. *H* informs *P* that it's time to switch to the other task by a gentle elbow to *P*'s ribs. However, *P* has an uncanny ability to hear crying babies, and if *P* hears a baby cry, he interrupts whatever task he is currently doing to kiss the baby before returning to the interrupted task. *P* adores babies and may spend quite a long time giving one a kiss; *H* may decide to allow *P* to decide when to stop kissing any baby, or may intervene by a gentle elbow to *P*'s ribs.

You should assume that each time *P* starts chewing gum, he requests a new piece from *H*, who provides it immediately (so that no time is spent waiting). Also, whenever *P* starts walking or goes to kiss a baby, *P* disposes of his gum by swallowing it.

Assume that *P* starts each day walking, rather than chewing or kissing.

- (a) [2 marks] Superimpose a world model on the domain model shown below of any politician. For a reminder of what is a world model, see Question 5.



- (b) **[10 marks]** Create a UML state machine diagram that models  $P$ . Be sure to account for all incoming events from outside  $P$ , including from  $H$  and any baby.

- (c) **[4 marks]** Give a use-case model of any politician,  $P$ , showing  $P$ 's handler  $H$  and *anyBaby* as actors. Make sure that you have one use case for each externally originating event in your state machine.

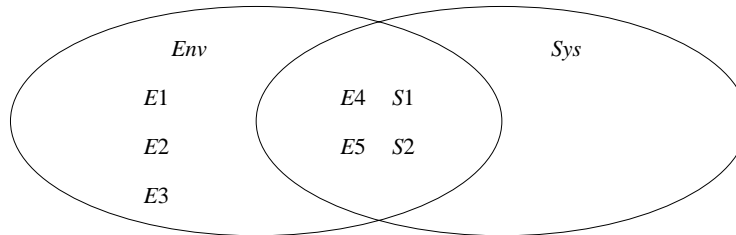
- (d) **[Bonus question, no marks, only bragging rights]**

What might the robot version of  $P$  dream about, if he's made by the Tyrell Corporation?

## 5. [14 total marks] Reference model and world models

Recall the fundamental formula  $D, S \vdash R$

The world model below divides the World into a system,  $Sys$ , to be implemented and the environment,  $Env$ , affected by  $Sys$ . It shows some entities in each part.



## (a) [4 marks]

The intersection between  $Sys$  and  $Env$  is called the \_\_\_\_\_.

$D$  is called the \_\_\_\_\_ for  $Sys$ .

$S$  is called the \_\_\_\_\_ of  $Sys$ .

$R$  is called the \_\_\_\_\_ of  $Sys$ .

## (b) [6 marks]

Assume that each of the below is the skeleton of a sentence that mentions exactly two of the entities in the diagram. For each sentence skeleton, list all of  $D$ ,  $S$ , and  $R$  that apply; if none applies, say “none”.

..  $E1 \dots E2 \dots$  \_\_\_\_\_

..  $E1 \dots E4 \dots$  \_\_\_\_\_

..  $E2 \dots E5 \dots$  \_\_\_\_\_

..  $E3 \dots S1 \dots$  \_\_\_\_\_

..  $E4 \dots S2 \dots$  \_\_\_\_\_

..  $S1 \dots S2 \dots$  \_\_\_\_\_

## (c) [2 marks]

If an  $S$  needs to keep time, where among  $Env$ ,  $Env \cap Sys$ ,  $Sys$ ,  $Env - Sys$ ,  $Sys - Env$ , and  $Env \cup Sys$  must “time” be?

## (d) [2 marks]

One simple way to prevent an  $S$  written as a state machine from going into design or implementation details that do not belong in a specification is to restrict the state machine’s vocabulary to entities that appear in \_\_\_\_\_ (part of the World).

**6. [10 total marks] Ambiguity**

Many a native English speaker might say the following sentence about a system like OGSAS:

The graduate director can only admit graduate students to UW.

Unfortunately this sentence means something other than what it is intended to mean and worse than that, there are several plausible meanings, plausible in the sense that one might indeed say such a thing about a system like OGSAS independently of whether it is true.

5 possible placements of **only** in this sentence are:

- (a) Only the graduate director can admit graduate students to UW,
- (b) The graduate director only can admit graduate students to UW,
- (c) The graduate director can only admit graduate students to UW,
- (d) The graduate director can admit only graduate students to UW,
- (e) The graduate director can admit graduate students to only UW,

Below are 5 follow-on clauses, each of which echos one of the 5 possible placements of **only**, by being consistent with only that one placement.

\_\_\_\_\_ and not any other professor in the university.

\_\_\_\_\_ and not undergraduate students.

\_\_\_\_\_ but not to WLU.

\_\_\_\_\_ but she cannot reject them.

\_\_\_\_\_ but she is not permitted to do so.

In the underscore before each of these follow-ons, write the letter labelling the **only** placement that is consistent with the follow-on.

## 7. [16 total marks] Temporal and time-based logic

For both parts of this question, assume that time units are in days. Thus, “today” is the initial state, “tomorrow” is the next state, *etc.*

(a) Consider the following definitions:

$F(x, y, t)$  means person  $x$  fools person  $y$  on day  $t$

$S(x, t)$  means person  $x$  feels shame / regrets something on day  $t$

Translate each of the below into *time-dependent logic*

i. [2 marks] Everyone will feel regret at least once.

ii. [3 marks] Everyone will fool himself at least once, but will regret it the next day.

iii. [3 marks] You will feel regret, not today, not tomorrow, but eventually and forever thereafter. (Assume that once you feel regret for the first time, the feeling never ends.)

(b) Consider the following (similar) definitions:

$F(x, y)$  means person  $x$  fools person  $y$

$S(x)$  means person  $x$  feels shame / regrets something

Translate each of the below into *linear temporal logic*

i. [2 marks] Everyone will feel regret at least once.

ii. [3 marks] Everyone will fool herself at least once, but will regret it the next day.

iii. [3 marks] You will feel regret, not today, not tomorrow, but eventually and forever thereafter. (Assume that once you feel regret for the first time, the feeling never ends.)