

Unit Code: CM20019

Unit Lecturer: Dr. P. Bruscoli

Coursework 1 – due 26 October 2006

Please read the following information and instructions for the coursework submission process:

- **Date, Time, Location for submission:**
This coursework is to be submitted through the coursework post box located outside 1W2.23 by 26 October 2006, at 5:00 pm. Please be careful to select the box relative to this course.
- **Form of submission:**
This coursework is to be submitted in written form, on paper, bound securely. Please make sure it contains information to identify you, clearly written: surname, first name, and student number. All students must include the coursework signature sheet.
- **The proportion of the total assessment for this coursework:**
This is the first of three courseworks, and they all will contribute the 25% of the final grade. This specific coursework contributes 100 points (over a total of 300 points in three courseworks) and contributes for the 8% of the final grade. This text includes several exercises, whose points are indicated at their beginning, possibly split among the set questions.
- **Condition of assessment:**
This is an individual coursework, and it should be completed within the student's own time. Tutors may be consulted according to their meeting times and agreements.
- **Specification:**
This coursework contains 7 exercises. Please provide clearly written solutions.
- **Deliverables:**
Please submit your solutions on paper, bound securely.
- **Marking Guidance:**
Single exercises in this text will be marked proportionally to the points they carry. The sum of all points obtained in this coursework will contribute to the points obtained at the end of all three courseworks.
- **Feedback:**
It will be provided by example solutions, or by discussing solutions during tutorials.

Exercise 1 [points: 6, 6]

The Morse code provides a representation of letters and digits in terms of strings built over the symbols \bullet and $-$. In particular, *Digits* are exactly represented as follows:

Digit	Morse code	Digit	Morse code
1	$\bullet - - - -$	6	$- \bullet \bullet \bullet \bullet$
2	$\bullet \bullet - - -$	7	$- - \bullet \bullet \bullet$
3	$\bullet \bullet \bullet - -$	8	$- - - \bullet \bullet$
4	$\bullet \bullet \bullet \bullet -$	9	$- - - - \bullet$
5	$\bullet \bullet \bullet \bullet \bullet$	0	$- - - - -$

Using an empty space (represented here by the character \$), we can express generic *Numbers*: for example, the Morse code of 42 is

$\bullet \bullet \bullet \bullet - \$ \bullet \bullet - - -$

1. Give a precise verbal description of the language of acceptable representations of *Numbers* in Morse code.
2. Give a grammar that generates the language of *Numbers*, indicating the exact underlying alphabet.

Exercise 2 [points: 3]

Draw the parse tree of the term $f(g(f(g(Y, f(Z))), g(f(X), Y)))$.

Exercise 3 [points: 5, 5]

Given the following substitutions σ and θ , compute their composition $\sigma \circ \theta$:

1. $\sigma = [X := f(Y, a), Y := U, U := f(Y, X)]$ and $\theta = [X := a, Y := f(U, a), V := f(a, U)]$;
2. $\sigma = [X := g(Z), Y := a, Z := g(b)]$ and $\theta = [Y := b, Z := X, U := X]$.

Exercise 4 [points: 6, 6, 6, 6]

Consider the following formulae S_i and substitutions σ_i , for $i = 1, \dots, 4$:

1. $S_1 = (\forall X)r(X, c) \rightarrow r(X, c)$, $\sigma_1 = [X := f(a)]$;
2. $S_2 = (\forall X)r(X, Y) \rightarrow (\exists Y)r(Y, c)$, $\sigma_2 = [X := f(Y), Y := a]$;
3. $S_3 = (\forall X)(\exists Y)(r(X, Y) \rightarrow s(a, Y))$, $\sigma_3 = [X := f(Y), Y := a]$;
4. $S_4 = (\forall X)(\exists Y)r(X, Y) \wedge s(a, Y)$, $\sigma_4 = [X := f(Y), Y := a]$.

For all these four cases indicate the occurrences of free and bound variables in each formula S_i and compute $S_i\sigma_i$.

Exercise 5 [points: 7, 7, 7]

Find most general unifiers for those of the following pairs of terms which are unifiable, where a, b and f are function symbols, and X, Y, Z, U and V are variables.

1. $f(X, f(g(Y), g(X)))$ and $f(f(a, Z), Z)$
2. $f(X, f(X, Y))$ and $f(Y, f(Y, a))$
3. $f(f(f(Y, a), f(a, b)), f(X, b))$ and $f(f(U, V), U)$

Exercise 6 [points: 20]

Translate the following text into some first order language. Please make clear the intended interpretation for each predicate and function symbol in the signature of the first order language you are using.

“Fishes are animals that live in the water. Some animals are mammals. Dolphins are mammals that live in the water, and they are not fishes.”

Exercise 7 [points: 10]

What’s wrong in the following statement?: ‘When I’ll be able to make these exercises I’ll pass the examination. It means, exactly, that I will not pass the examination if I cannot do them.’