Surprise Test-2.1

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1. Aim/Overview of the practical:

Difference between predicate and propositional logic.

2. Theories:

Propositional logic

Proposition is any sentence that can be assigned a truth value, such as “Helsinki is the capital of Finland”, “Tapirs are cuddly”, “Cheese tastes better than candy”, or “It rains”. The versatility (and restriction) of propositional logic lies in the fact that we can use it with any statement whatsoever, regardless of its inner structure or logical form.

But it is also very, very simple. Elementary propositions are denoted usually by letters, such as lower-case *p* and *q*. These propositions are connected to each other and manipulated using simple logical connectives, such as:

¬¬ for *not*,
∧∧ for *and*,
∨∨ for *or*,
⇒⇒ for *if, then*,
⇔⇔ for *if and only if*,
Using these symbols, we can generate combinations of the elementary propositions to claim certain logical connections between them. For example, “If cheese tastes better than candy, it rains”:

p ⇒⇒ *q*,
where *p* is the elementary proposition “Cheese tastes better than candy” and *q* is “It rains”.

We then use so-called truth tables to evaluate the truth of this complex proposition. We can also determine whether it is a tautology (logical truth). In the truth-table method we go through all combinations of *p* and *q* as to their truth and falsity and see what the truth value of the whole proposition is.

Like so:

P	Q	R	$P \to Q$	$Q \to R$	$(P \to Q) \wedge (Q \to R)$
T	T	T	T	T	T
T	T	F	T	F	F
T	F	T	F	T	F
T	F	F	F	T	F
F	T	T	T	T	T
F	T	F	T	F	F
F	F	T	T	T	T
F	F	F	T	T	T

If the last column has only *T* in it (sometimes +/- or 1/0 are used for truth and falsity), the proposition is a tautology; if it has only *F* in it, it is a contradiction.

Predicate logic

Predicate logic is essentially a system where the elementary propositions of propositional logic can be further analysed using predicates/properties that are assigned to subjects. For example, above "Helsinki is the capital of Finland" can be further analysed by denoting Helsinki with the lower-case letter *h* and the predicate *the capital of Finland* with a upper-case letter, say *C*. We get: "*h* is *C*".

Predicate logic has standardly employed so-called quantifiers, which express the scope of the predicate over the subject-term. In the above case Helsinki is an individual object, so a quantifier makes little sense – so take the tapir example: now the subject-term is the general concept of tapir – denote it with *T*, and cuddly with *C*. Since the statement in effect claims that *all* tapirs are cuddly, we write: "All T are C". This is the traditional Aristotelian way of expressing the matter. But the quantifier itself in modern predicate logic is expressed by one of the two symbols:

Universal quantifier ∀∀, meaning *all*, *every*
Existential quantifier ∃∃, meaning *some, there exists*
This quantifier is then applied to a set of entities, denoted by lower case letters such as *x* or *y*. Now we can express the idea that all tapirs are cuddly by saying that of all the entities that are tapirs, it is true that they are cuddly – or, better still, for all entities whatsoever, it is true that *if* they are tapirs, they are also cuddly:

$\forall\forall x(Tx \Rightarrow\Rightarrow Cx)$

Thus we see that unlike propositional logic, predicate logic is capable of dealing with *sets of entities* – making it very useful e.g. in mathematics.

Unfortunately, this property also makes it impossible to employ truth tables in predicate logic: one would have to iterate over a potential infinity of individuals. Instead, in determining the validity of inferences in predicate logic, simple logical rules are established and iterated. For example, we can apply the rule that negating the universal quantifier gives us the existential quantifier with the negation of the proposition:

¬¬∀∀*x*(*Px*) ⇔⇔ ∃∃*x*(¬¬*Px*)

Since in addition we can also use all the logical rules established in propositional logic to the propositions themselves, we have a very powerful and versatile form of logic.

Evaluation Grid (To be created as per the SOP and Assessment guidelines by the faculty):

Sr. No.	Parameters	Marks Obtained	Maximum Marks
1.			
2.			
3.			