ชื่อ _____ รหัสนักศึกษา_____

# Lab 1 : Introduction to Wolfram Mathematica for Logic and Proofs

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## Task 1 : How to display text and value

In[•]:=
```
Print["Hello CPE111"]
```

In[•]:=
```
"Hello CPE111"
```

---

## Task 2 : Variable and Datatype

In[•]:=
```
a = 10
```

In[•]:=
```
b := 10
```

In[•]:=
```
c = 10;
```

string

In[•]:=
```
"Hello World"
```

In[•]:=
```
a = "Hello World"
```

---

## Task 3 : Operations

In[•]:=
```
a = 5;
b = 2;
a + b
```

In[•]:=
```
a * b
```

In[•]:=
```
a / b
```

In[•]:=
```
N[%]
```

In[•]:=
```
a ^ b
```

```
In[ ]:= myValue = {10, 20, 30};
```

```
In[ ]:= myValue + 10
```

### Todo : List the first 10 terms of the sequence "$2(-3)^n+5^n$"

```
(*write your code here*)
```

```
In[ ]:= y = 2x + 5
```

```
In[ ]:= y /. x→5
```

---

# Task 4 : Propositional Logic

```
In[ ]:= prop
```

```
In[ ]:= prop = True
```

```
In[ ]:= prop
```

To remove the assigned value

```
In[ ]:= Clear[prop]
```

```
In[ ]:= prop =.
```

## Logical Connectives

| name | function | without alias | alias | symbol |
|---|---|---|---|---|
| negation | **Not** | **!** | ESC not ESC | ¬ |
| conjunction | **And** | **&&** | ESC and ESC | ∧ |
| exclusive or | **Xor** | | ESC xor ESC | ⊻ |
| disjunction | **Or** | \|\| | ESC or ESC | ∨ |
| biconditional | **Equivalent** | | ESC equiv ESC | ⟺ |
| implication | **Implies** | | ESC = > ESC | ⇒ |

```
In[ ]:= Or[True, False]
```

```
In[ ]:= Implies[True,And[False,True]]
```

```
In[ ]:= Xor[True,True]
```

```
In[ ]:= !True
```

```
In[ ]:= (True||False)&&True
```

```
In[ ]:= True ∧ False
```

```
In[ ]:= False ⇒ False
```

## Evaluating Expressions

```
In[ ]:= prop = !p
```

```
In[ ]:= p = True
```

```
In[ ]:= prop
```

```
In[ ]:= prop /.p→True
```

```
In[ ]:= p&&(!q)/.{p→True,q→False}
```

### Todo : Find the truth value of (p∧(¬q)) → (r⟺q) when p = True, q = False and r = False

```
(*write your code here*)
```

## Truth Tables

```
In[ ]:= Clear[p, q]
```

```
In[ ]:= BooleanTable[p&&(!q),{p,q}]
```

```
In[ ]:= BooleanTable[{p, q, p&&(!q)},{p,q}]
```

```
In[ ]:= BooleanTable[{p, q, p&&(!q)},{p,q}] // TableForm
```

### Todo : Construct the truth table of the compound proposition

$(p \vee \neg q) \Rightarrow (p \vee q)$

```
(*write you code here*)
```

$(q \to \neg p) \leftrightarrow (p \leftrightarrow q)$

```
(*write you code here*)
```

$(p \to q) \wedge (\neg p \to r)$

```
(*write you code here*)
```

# Task 5 : Propositional Equivalence

In[ ]:=
```
TautologyQ[Equivalent[!(p&&q), !p||!q], {p, q}]
```

### Todo : Show that the following statements are logically equivalent.

$\neg (p \oplus q)$ and $p \leftrightarrow q$

```
(*write you code here*)
```

$(p \rightarrow r) \wedge (q \rightarrow r)$ and $(p \vee q) \rightarrow r$

```
(*write you code here*)
```

---

# Task 6 : Predicates and Quantifiers

In[ ]:=
```
gt0[x_] := x > 0
```

In[ ]:=
```
gt0[5]
```

In[ ]:=
```
gt0[-3]
```

## Representation of Quantifiers

```
ForAll[x, P[x]]
```

In[ ]:=
```
Exists[x, -x < 0]
```

In[ ]:=
```
ForAll[x, x > 0, -x < 0]
```

In[ ]:=
```
Exists[x, Element[x, Reals], x^2 < 0]
```

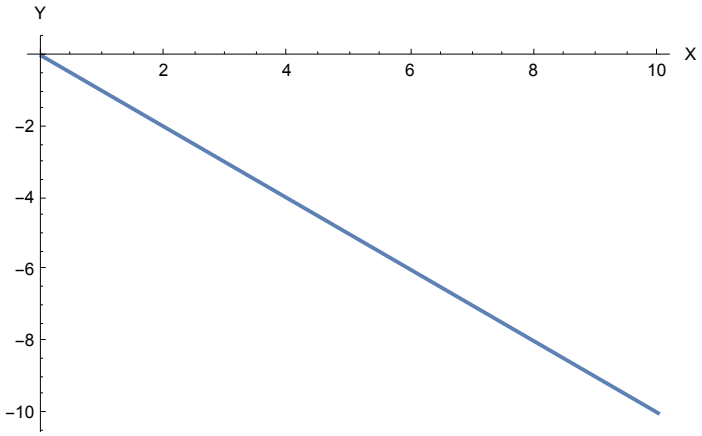
## Truth Value of Quantified Statements

In[ ]:=
```
Resolve[Exists[x, -x < 0]]
```

In[ ]:=
```
Resolve[ForAll[x, x > 0, -x < 0]]
```

In[ ]:=
```
Plot[-x, {x, 0, 10}, AxesLabel→{"X", "Y"}]
```

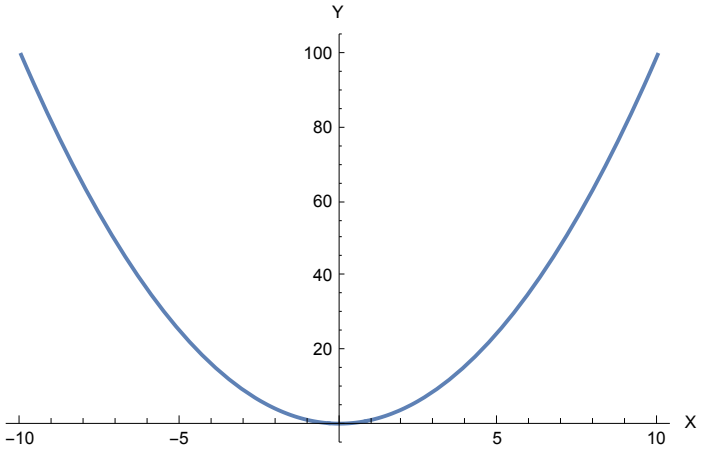
Out[ ]=




In[ ]:=
```
Resolve[Exists[x, Element[x, Reals], x^2 < 0]]
```

In[ ]:=
```
Plot[x^2, {x, -10, 10}, AxesLabel→{"X", "Y"}]
```

Out[ ]=



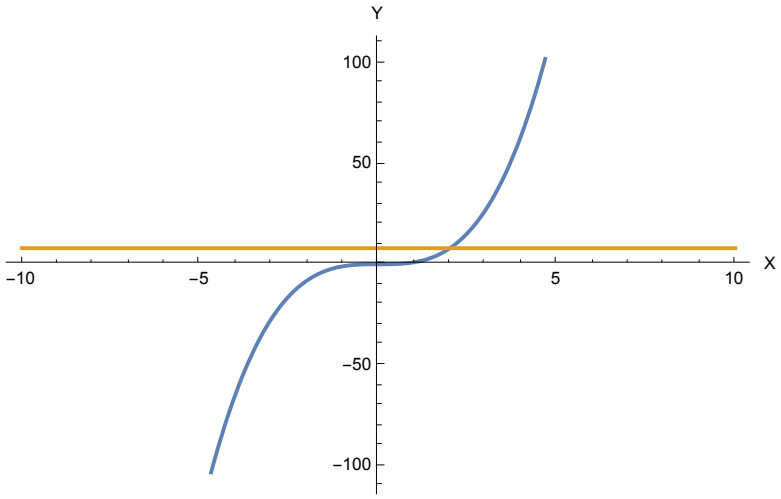

In[ ]:=
```
Resolve[Exists[x, x^2 < 0], Reals]
```

In[ ]:=
```
Resolve[Exists[x, x^2 < 0],Complexes]
```

In[ ]:=
```
Resolve[Exists[x, x^3 == 8]]
```

In[ ]:=
```
Plot[{x^3, 8}, {x, -10, 10}, AxesLabel→{"X", "Y"}]
```

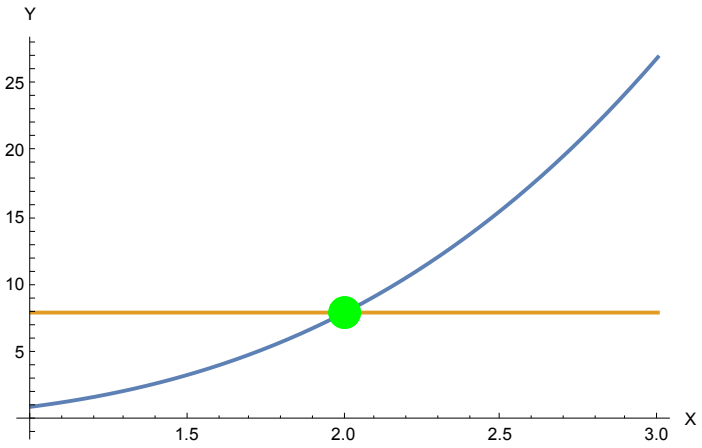
Out[ ]=




In[ ]:=
```
FindInstance[x^3 == 8, x]
```

In[ ]:=
```
Show[
    Plot[{x^3, 8}, {x, 1, 3}, AxesLabel→{"X", "Y"}],
    ListPlot[{{2, 8}}, PlotStyle→{PointSize[0.05], Green}]
]
```

Out[ ]=




In[ ]:=
```
FindInstance[x^3 == 8, x, 3]
```

In[ ]:=
```
FindInstance[x^3 == 8, x, Integers, 3]
```

## Todo : Determine the truth value and plot the graph of each of these statements if the domain for all variables consists of all **real** numbers

$\exists\, x\left(x^3 = -1\right)$

```
(*write your code here*)
```

```
(*write your code here*)
```

$\exists\, x\left(x^4 < x^2\right)$

```
(*write your code here*)
```

```
(*write your code here*)
```

$\forall\, x((-x)\,\hat{}\,2) = x^2\Big)$

```
(*write your code here*)
```

```
(*write your code here*)
```

$\forall$ x(2 x > x)

```
(*write your code here*)
```

```
(*write your code here*)
```

# Task 7 : Rule of Inference

In[ ]:=
```
TautologyQ[Implies[(!q&&Implies[p, q]), !p]]
```

For example, state which rule of inference is used in the argument:

If it snows today ❄️, then we will go skiing ⛷️

It is snowing today ❄️.

Therefore, we will go skiing ⛷️.

In[ ]:=
```
premise = {{❄️ ⇒ ⛷️}, ❄️};
conclusion = ⛷️;
conjPremise = Apply[And, premise]
TautologyQ[Implies[conjPremise,conclusion]]
```

## Todo : Show that these premises lead to the conclusion, and state which rules of inference are applied.

If I finish my project 📝, then I will submit it online 🌐.
If I submit it online 🌐, then I will get feedback 📩.
I finished my project 📝.
Therefore, I will get feedback 📩.

write your steps here

```
(*write your code here*)
```

If I study hard 📖, then I will pass the exam 🎓.
If I pass the exam 🎓, then I will graduate 🎉.
If I do not graduate ¬🎓, then I will not get a job ¬💼.
I studied hard 📖.

write your steps here

```
(*write your code here*)
```