Methods of Proofs

$$p_1, p_2, \ldots, p_n \Downarrow p_{n+1}$$

$$\dfrac{p \to q \quad q \to r}{p \to r}$$

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$$\dfrac{L \to F \quad L}{F} \qquad \dfrac{F \to M \quad \neg M}{\neg F}$$

L	F	L→F
0	0	1 T
0	1	1 T
1	0	F
1	1	T

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$$\dfrac{p}{p \vee q} \qquad \dfrac{p \quad q}{p \wedge q} \qquad \dfrac{p \wedge q}{p}$$

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(1) $L \to F$ Rule (1)+(2)

(2) $F \to M$ $\quad L \to M \to$ (4)

(3) $\neg M$ $\quad$ (3)+(4) $\to \neg L$

$$\dfrac{L \to F \quad F \to M \quad \neg M}{\neg L}$$

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$$\dfrac{B \wedge S \quad [B \vee S \to P]}{?\,P}$$

$B, S \Rightarrow B \vee S$

$$\dfrac{B \vee S \to P}{P}$$

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Relation

$$R = \{(x,y) \in S \times T, y = f(x)\}$$

$$\check{R} = \{(x,y) \in \mathbb{N} \times \mathbb{N} : x \leq y\}$$

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Reflexive, $x \leq y$

$x R x$ $x \leq x$

symmetric

$(x,y) \in R \Rightarrow (y,x) \in R$

$x = y \Rightarrow y = x$

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transitive

$(x,y) \in R$ and $(y,z) \in R$

$\Rightarrow (x,z) \in R$

$x \leq y \wedge y \leq z \Rightarrow x \leq z$

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for the following relations on $S = \{0,1,2,3\}$ specify which of the properties the relation satisfies

$(m,n) \in R_1$ if $m+n=3$

$(m,n) \in R_2$ if $m=3$

not reflexive

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symmetric

$(m,n) \in R_1$ $m+n=3$

$(n,m) \in R_1 \Leftarrow n+m=3$

$(m,n) \in R_1$ $m+n=3$

$(n,0) \in R_1$ $(m,n) = \{(0,3),(3,0),(2,1),(1,2)\}$

$m+0 \in R_1$

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$A = \{0,1,2\}$

$m.n = 0$ Ref: $m \times m = 0$

$m \times n = 0$

$\neq 0$

$m \times n = 0$

$n \times p = 0$

$\neq 0$

$n \times p \neq 0$

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$(m,n) = \{(3,0),(0,3),(2,1),(1,2)\}$

$(m,n) = (3,0)$

$(n,p) = (0,p)$

$= 3$

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Induction

$$\sum_{i=1}^{n} i = 1+2+3+4+\cdots+n$$

$$= \frac{n(n+1)}{2}$$

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Proof by induction

1. initial step.
2- Hypothesis
3- Proof

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$\forall n \in \mathbb{N}: n \leqslant n^2$ $\quad a+b \leqslant c+d$, $a \leqslant c$

1- $n=0$ $\quad 0 \leqslant 0$ (TRue)

2- $n=k$ $\quad k \leqslant k^2$ (نفرض صحيح)

3- $n=k+1$ $\quad \Rightarrow 1 \leqslant 2k+1$

$k+1 \leqslant (k+1)^2$. $\quad 2k \geqslant 0$

$k+1 \quad k^2+2k+1$

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$\forall n \in \mathbb{N}^*: 1+2+\cdots+n = \frac{n(n+1)}{2}$

1) $1 = \frac{1(2)}{2}$

2) $k \in \mathbb{N}^*$ $\quad 1+2+\cdots+k = \frac{k(k+1)}{2}$

3) $1+\cdots+k+(k+1) \overset{?}{=} \frac{(k+1)(k+2)}{2}$

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$$\underbrace{1+2+\cdots+k}_{\text{مفروضة}}+(k+1)$$

$$\frac{k(k+1)}{2}+(k+1)$$

$$\frac{k(k+1)+2(k+1)}{2} = \frac{(k+1)(k+2)}{2}$$

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$P(n) = n^2+5n \qquad n \in \mathbb{N}^*$

Prove that $P(n)$ is even

1) $P(1) = 1+5 = 6 =$

2) $P(k) = k^2+5k$

3) $P(k+1) = (k+1)^2+5(k+1)$

$= k^2+2k+1+5k+5$

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$P(K) = K^2 + 5K$ even فرضية

$P(K+1) = K^2 + 2K + 1 + 5K + 5$

$= K^2 + 5K + 2K + 6$

$P(n)$ is even.

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Prove that

$n^2 > n+1$ for $n \geq 2$

① $P(2) = 2^2 > 2+1$ True

② $P(k) = k^2 > k+1$ True

③ $(k+1)^2 > (k+1)+1$ that prove نثبت

$k^2+2k+1 > (k+1)+1$ من الفرضية

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$k^2 > k+1$

$k^2 + 2k + 1 \quad (k+1)+1$

من الفرضية

$2k + \cancel{1} > \cancel{1}$

$2k > 0$

$P(k+1)$ True

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