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1. $f(0) = 0$ $f(1) = \frac{f'(0)}{1} x^1 = (1+2x)\cos(x+x^2) \cdot x = x$

$f(2) = \frac{f''(0)}{2!} x^2 =$ so $f(2) = \frac{2}{2} x^2 = x^2$

$f''(x) = 2\cos(x+x^2) - (1+2x)^2 \sin(x+x^2)$

$f''(0) = 2 - 0 = 2$

2. $n=0 \Rightarrow x+x^2$

$n=1 \Rightarrow -\frac{1}{6}(x+x^2)^3$

$n=2 \Rightarrow \frac{1}{5!}(x+x^2)^5$

$n=3 \Rightarrow -\frac{1}{7!}(x+x^2)^7$

$n=4 \Rightarrow \frac{1}{9!}(x+x^2)^9$

3. $z = -t^2$ $\arctan x = \int_0^x \sum_{n=0}^{\infty} (-t^2)^n \, dt$

4. As $\tan(\alpha+\beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha\tan\beta}$

$\tan(\arctan x + \arctan y) = \frac{\tan(\arctan x) + \tan(\arctan y)}{1 - \tan(\arctan x)\tan(\arctan y)}$

$f(f^{-1}(x)) = x$

so $\tan(\arctan x + \arctan y) = \frac{x+y}{1-xy}$

so $\arctan x + \arctan y = \arctan \frac{x+y}{1-xy}$

5. $\arctan\frac{1}{2} + \arctan\frac{1}{3} = \arctan\dfrac{\frac{1}{2}+\frac{1}{3}}{1-\frac{1}{2}\cdot\frac{1}{3}} = \arctan\dfrac{\frac{5}{6}}{1-\frac{1}{6}} = \arctan 1$

$= \frac{\pi}{4}$