

Note: when $p < \text{power of } g(n)$
then ans $\boxed{T.C = g(n)}$

$$p = \cancel{4} - 2 < 2$$

Hence

$$g(n) = n^2$$

$p < 2$ i.e power of $g(n)$
ans $O(g(n))$

$$\begin{aligned}
T(x) &= O\left(x^p + x^p \int_1^x \frac{u^2}{u^{p+1}} du\right) \\
&= O\left(x^p + x^p \int_1^x \left(u^2, u^{-(p+1)}\right) du\right) \\
&= O\left(x^p + x^p \int_1^x u^{2-p-1} du\right) \\
&= O\left(x^p + x^p \int_1^x u^{1-p} du\right) \\
&= O\left(x^p + x^p \left(\frac{u^{1-p+1}}{1-p+1} \right)_1^x\right) \\
&= O\left(x^p + x^p \left(\frac{u^{2-p}}{2-p} \right)_1^x\right)
\end{aligned}$$

$$\begin{aligned}
 &= \Theta(x^p + x^p \left(\frac{x^{2-p}}{2-p} - \frac{x^{1-p}}{2-p} \right)) \\
 &= \Theta(\underline{x^p} + \frac{x^p \cdot x^{2-p}}{2-p})
 \end{aligned}$$

$$= \Theta(x^p + x^p \cdot \frac{x^2 \cdot \cancel{x^p}}{2-p})$$

$$\begin{aligned}
 &= \Theta(\underbrace{\cancel{x^p}}_{\text{less dom}} + x^2) = \Theta(x^2)
 \end{aligned}$$

