$$T(n) = 4T\left(\frac{n}{2}\right) + n^2 \log n$$

$$= 4\left[4T\left(\frac{n}{2^2}\right) + \frac{n^2 \log n}{2}\right] + n^2 \log n$$

$$= 4^2 T\left(\frac{n}{2^2}\right) + \frac{4n^2 \log n}{2} + n^2 \log n$$

$$= 4^2\left[4T\left(\frac{n}{2^3}\right) + \frac{n^2 \log n}{2^2}\right] + \frac{4n^2 \log n}{2} + n^2 \log n$$

$$= 4^3 T\left(\frac{n}{2^3}\right) + \frac{4^2 n^2 \log n}{2^2} + \frac{4n^2 \log n}{2} + n^2 \log n$$

$$+ (4 + 2 + 1)\, n^2 \log n$$

$$+ (2^2 + 2^1 + 2^0)\, n^2 \log n$$

$$+ \left(\sum_{i=0}^{k-1} 2^i\right) n^2 \log n$$

$$= 4^k T\left(\frac{n}{2^k}\right) + (2^k - 1)\, n^2 \log n$$

$$\frac{n}{2^k} = 1 \Rightarrow n = 2^k \Rightarrow \log_2 n = \log_2 2^k \Rightarrow \log_2 n = k$$

$$= 4^{\log_2 n}\, T(1) + (2^{\log_2 n} - 1)\, n^2 \log n$$

$$= n^{\log_2 4}\, T(1) + (n^{\log_2 2} - 1)\, n^2 \log n$$

$$= n^2\, T(1) + (n-1)\, n^2 \log n$$

$$\therefore O(n^2 \log n)$$