Supplementary material

for review of the manuscript

Properties and Approximate p-value Calculation of the Cramer test

1 Statistical properties of the test statistic $T_{n,m}$

Using the notation and definition as in the main manuscript, we present the proof for the expected value $\mathrm{E}[T_{n,m}]$ and variance $\mathrm{Var}[T_{n,m}]$ of the test statistic $T_{n,m}$ in the case of $n \neq m$.

Proposition 1 The expectation of the test statistic $T_{n,m}$ where $n > m$ follows the following formula;

$$\mathrm{E}[T_{n,m}] = \int_{-\infty}^{\infty} \left(H(t) - H(t)^2\right) dt,$$

where $H(t)$ is the distribution of the two data sets under the null hypothesis.

Proof Consider the test statistic

$$T_{n,m} = \frac{nm}{n+m} \int_{-\infty}^{\infty} (\hat{F}(t) - \hat{G}(t))^2 dt \tag{1}$$

where

$$\hat{F}(t) = \frac{1}{n} \sum_{i=1}^{n} 1_{\{x_i \leq t\}};$$

$$\hat{G}(t) = \frac{1}{m} \sum_{i=1}^{m} 1_{\{y_i \leq t\}},$$

the empirical cumulative distribution functions for distributions f and g respectively.

The formulas for the empirical cumulative distribution function can be substituted into equation (1) to give

$$T_{n,m} = \frac{nm}{n+m} \int_{-\infty}^{\infty} \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} 1_{\{x_i \leq t\}} 1_{\{x_j \leq t\}} - \frac{2}{nm} \sum_{i=1}^{n} \sum_{j=1}^{m} 1_{\{x_i \leq t\}} 1_{\{y_j \leq t\}} + \frac{1}{m^2} \sum_{i=1}^{m} \sum_{j=1}^{m} 1_{\{y_i \leq t\}} 1_{\{y_j \leq t\}} dt.$$

Now, the expectation of the test statistic can be calculated as follows;

$$\begin{aligned}
\mathrm{E}[T_{n,m}] &= \frac{nm}{n+m} \int_{-\infty}^{\infty} \left(\frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \mathrm{E}\left[1_{\{x_i \leq t\}} 1_{\{x_j \leq t\}}\right] - \frac{2}{nm} \sum_{i=1}^{n} \sum_{j=1}^{m} \mathrm{E}\left[1_{\{x_i \leq t\}} 1_{\{y_j \leq t\}}\right] \right. \\
&\quad \left. + \frac{1}{m^2} \sum_{i=1}^{m} \sum_{j=1}^{m} \mathrm{E}\left[1_{\{y_i \leq t\}} 1_{\{y_j \leq t\}}\right] \right) dt \\
&= \frac{nm}{n+m} \int_{-\infty}^{\infty} \left(\frac{n-1}{n} \mathrm{E}\left[1_{\{x_i \leq t\}}\right] \mathrm{E}\left[1_{\{x_j \leq t\}}\right] + \frac{1}{n} \mathrm{E}\left[1_{\{x_i \leq t\}}\right] \right. \\
&\quad - 2\mathrm{E}\left[1_{\{x_i \leq t\}}\right] \mathrm{E}\left[1_{\{y_j \leq t\}}\right] + \frac{m-1}{m} \mathrm{E}\left[1_{\{y_i \leq t\}}\right] \mathrm{E}\left[1_{\{y_j \leq t\}}\right] \\
&\quad \left. + \frac{1}{m} \mathrm{E}\left[1_{\{y_i \leq t\}}\right] \right) dt.
\end{aligned}$$

Now, under the null hypothesis, the data points $x_1, x_2, \ldots, x_n$ and $y_1, y_2, \ldots, y_m$ are assumed to follow the same distribution, namely $H(t)$. Hence

$$\mathrm{E}\left[1_{\{x_i \le t\}}\right] = \mathrm{E}\left[1_{\{y_i \le t\}}\right] = H(t).$$

Thus,

$$\mathrm{E}[T_{n,m}] = \int_{-\infty}^{\infty} \left(H(t) - H(t)^2\right) dt.$$

□

Proposition 2 The variance of the test statistic $T_{n,m}$ where $n > m$ follows the following formula;

$$\mathrm{Var}[T_{n,m}] = \frac{2(n^3+m^3)}{nm(n+m)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{t} H(s) \Bigg(1 + 2\left(\frac{nm(n+m)^2}{n^3+m^3} - 2\right) H(s) - 3H(t)$$
$$- 2\left(\frac{2nm(n+m)^2}{n^3+m^3} - 5\right) H(s)H(t) + 2H(t)^2 + 2\left(\frac{nm(n+m)^2}{n^3+m^3} - 3\right) H(s)H(t)^2 \Bigg) ds\ dt$$

where $H(t)$ is the distribution of the two data sets under the null hypothesis.

Proof Consider the test statistic

$$T_{n,m} = \frac{nm}{n+m} \int_{-\infty}^{\infty} (\hat{F}(t) - \hat{G}(t))^2 dt \tag{2}$$

where

$$\hat{F}(t) = \frac{1}{n} \sum_{i=1}^{n} 1_{\{x_i \le t\}}$$

and

$$\hat{G}(t) = \frac{1}{m} \sum_{i=1}^{m} 1_{\{y_i \le t\}}$$

are the empirical cumulative distribution functions for the distributions f and g, respectively.

From the standard theory,

$$\mathrm{Var}[T_{n,m}] = \mathrm{E}[T_{n,m}^2] - \{\mathrm{E}[T_{n,m}]\}^2$$

and we have the expression for $\mathrm{E}[T_{n,m}]$ from Proposition 1. We now focus to obtain the expression for $\mathrm{E}[T_{n,m}^2]$.

Now,

$$\begin{aligned}
\mathrm{E}[T_{n,m}^2] &= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} (\hat{F}(t)-\hat{G}(t))^2(\hat{F}(s)-\hat{G}(s))^2 ds\ dt \\
&= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \mathrm{E}\Bigg[\frac{1}{n^4}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{n} 1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}} \\
&\quad - \frac{2}{n^3 m}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{m} 1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}} \\
&\quad + \frac{1}{n^2 m^2}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{m}\sum_{l=1}^{m} 1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}} \\
&\quad - \frac{2}{n^3 m}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n} 1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}} \\
&\quad + \frac{4}{n^2 m^2}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m} 1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}} \\
&\quad - \frac{2}{n m^3}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m} 1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}} \\
&\quad + \frac{1}{n^2 m^2}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n} 1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}} \\
&\quad - \frac{2}{n m^3}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m} 1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}} \\
&\quad + \frac{1}{m^4}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m} 1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\Bigg] ds\ dt. \qquad (3)
\end{aligned}$$

Each term in equation (3) can be calculated separately. For the first term in equation (3), we have

$$\begin{aligned}
&\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \frac{1}{n^4}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{n} \mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right] ds\ dt = \\
&\quad \frac{1}{n^4}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{ n\mathrm{E}\left[1^2_{\{x_i\le t\}}1^2_{\{x_i\le s\}}\right] + 2n(n-1)\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{x_j\le s\}}\right] \\
&\quad + 2n(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1^2_{\{x_i\le s\}}\right] + n(n-1)\mathrm{E}\left[1^2_{\{x_i\le t\}}1^2_{\{x_j\le s\}}\right] \\
&\quad + 2n(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{x_j\le t\}}1_{\{x_i\le s\}}\right] \\
&\quad + n(n-1)(n-2)\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{x_j\le s\}}1_{\{x_k\le s\}}\right] \\
&\quad + n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1^2_{\{x_k\le s\}}\right] \\
&\quad + 4n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{x_j\le s\}}1_{\{x_k\le t\}}\right] \\
&\quad + n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]\Big\} ds\ dt. \qquad (4)
\end{aligned}$$

Now, equation (4) is equivalent to

$$\frac{1}{n^4}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]ds\ dt =$$

$$\begin{aligned}
&\frac{1}{n^4}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{n\mathrm{pr}\{X_i\le\min(s,t)\}+2n(n-1)\mathrm{pr}\{X_i\le\min(s,t)\}\,\mathrm{pr}\{X_i\le s\}\\
&+2n(n-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le\min(s,t)\}+n(n-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le s\}\\
&+2n(n-1)\mathrm{pr}\{X_i\le\min(s,t)\}\,\mathrm{pr}\{X_j\le\min(s,t)\}\\
&+n(n-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{X_k\le s\}\\
&+n(n-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{X_k\le s\}\\
&+4n(n-1)(n-2)\mathrm{pr}\{X_i\le\min(s,t)\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{X_k\le s\}\\
&+n(n-1)(n-2)(n-3)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{X_k\le s\}\,\mathrm{pr}\{X_l\le s\}\Big\}ds\ dt,
\end{aligned}$$

which, under the null hypothesis, is equivalent to

$$\frac{1}{n^4}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]ds\ dt =$$

$$\begin{aligned}
&\frac{1}{n^4}\int_{-\infty}^{\infty}\Bigg\{\int_{-\infty}^{t}\Big\{nH(s)+4n(n-1)H(s)^2+3n(n-1)H(s)H(t)\\
&\qquad+5n(n-1)(n-2)H(s)^2H(t)+n(n-1)(n-2)H(s)H(t)^2\\
&\qquad+n(n-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\\
&\quad+\int_{t}^{\infty}\Big\{nH(t)+4n(n-1)H(t)^2+3n(n-1)H(s)H(t)\\
&\qquad+n(n-1)(n-2)H(s)^2H(t)+5n(n-1)(n-2)H(s)H(t)^2\\
&\qquad+n(n-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\Bigg\}dt.
\end{aligned}$$

Next, the second term in equation (3) can be calculated as

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}-\frac{2}{n^3m}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt =$$

$$\begin{aligned}
&-\frac{2}{n^3m}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{y_i\le s\}}\right]+m(n-1)\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{y_j\le s\}}\right]\\
&+m(n-1)\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{y_i\le s\}}1_{\{x_j\le s\}}\right]+2m(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{y_i\le s\}}1_{\{x_j\le t\}}\right]\\
&+m(n-1)\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{x_j\le s\}}1_{\{y_j\le s\}}\right]+2m(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{x_j\le t\}}1_{\{y_j\le s\}}\right]\\
&+m(n-1)(n-2)\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{x_j\le s\}}1_{\{y_k\le s\}}\right]\\
&+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{x_j\le t\}}1_{\{y_k\le s\}}\right]\\
&+3m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le s\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}\right]\\
&+m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right]\Big\}ds\ dt. \qquad (5)
\end{aligned}$$

Now, equation (5) is equivalent to

$$
\begin{aligned}
&-\frac{2}{n^3m}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt = \\
&\qquad -\frac{2}{n^3m}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{pr}\{X_i\le\min(s,t)\}\,\mathrm{pr}\{Y_i\le s\} \\
&\qquad +m(n-1)\mathrm{pr}\{X_i\le\min(s,t)\}\,\mathrm{pr}\{Y_j\le s\} \\
&\qquad +m(n-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{X_j\le s\} \\
&\qquad +2m(n-1)\mathrm{pr}\{X_i\le\min(s,t)\}\,\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{X_j\le t\} \\
&\qquad +m(n-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_j\le s\} \\
&\qquad +2m(n-1)\mathrm{pr}\{X_i\le\min(s,t)\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_j\le s\} \\
&\qquad +m(n-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_k\le s\} \\
&\qquad +2m(n-1)(n-2)\mathrm{pr}\{X_i\le\min(s,t)\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_k\le s\} \\
&\qquad +3m(n-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{X_k\le s\} \\
&\qquad +m(n-1)(n-2)(n-3)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{X_k\le s\}\,\mathrm{pr}\{Y_l\le s\}\Big\}ds\ dt,
\end{aligned}
$$

which, under the null hypothesis, is equivalent to

$$
\begin{aligned}
&-\frac{2}{n^3m}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt = \\
&\quad -\frac{2}{n^3m}\int_{-\infty}^{\infty}\Bigg\{\int_{-\infty}^{t}\Big\{mnH(s)^2+6m(n-1)H(s)^2H(t)+3m(n-1)(n-2)H(s)^2H(t) \\
&\qquad +3m(n-1)(n-2)H(s)^2H(t)^2+m(n-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds \\
&\quad +\int_{t}^{\infty}\Big\{nmH(t)H(s)+2m(n-1)H(s)^2H(t)+m(n-1)(n-2)H(s)^2H(t) \\
&\qquad +4m(n-1)H(s)H(t)^2+2m(n-1)(n-2)H(t)^2H(s) \\
&\qquad +3m(n-1)(n-2)H(s)^2H(t)^2+m(n-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\Bigg\}dt.
\end{aligned}
$$

Next, the third term in equation (3) can be calculated as

$$
\begin{aligned}
&\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\frac{1}{n^2m^2}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{m}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt \\
&\qquad \frac{1}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{E}\left[1^2_{\{x_i\le t\}}1^2_{\{y_i\le s\}}\right]+2m(n-1)\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{y_i\le s\}}1_{\{y_j\le s\}}\right] \\
&\qquad +2m(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1^2_{\{y_j\le s\}}\right]+m(n-1)\mathrm{E}\left[1^2_{\{x_i\le t\}}1^2_{\{y_j\le s\}}\right] \\
&\qquad +2m(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le s\}}1_{\{x_j\le t\}}1_{\{y_j\le s\}}\right] \\
&\qquad +m(n-1)(n-2)\mathrm{E}\left[1^2_{\{x_i\le t\}}1_{\{y_j\le s\}}1_{\{y_k\le s\}}\right] \\
&\qquad +m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1^2_{\{y_k\le s\}}\right] \\
&\qquad +4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le s\}}1_{\{x_j\le t\}}1_{\{y_k\le s\}}\right] \\
&\qquad +m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right]\Big\}ds\ dt. \qquad (6)
\end{aligned}
$$

Now, equation (6) is equivalent to

$$\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{m}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt =$$

$$\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le s\}+2m(n-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{Y_j\le s\}$$
$$+2m(n-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_j\le s\}+m(n-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_j\le s\}$$
$$+2m(n-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_j\le s\}$$
$$+m(n-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{Y_k\le s\}$$
$$+m(n-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_k\le s\}$$
$$+4m(n-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_k\le s\}$$
$$+m(n-1)(n-2)(n-3)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_k\le s\}\,\mathrm{pr}\{Y_l\le s\}\Big\}ds\ dt,$$

which, under the null hypothesis, is equivalent to

$$\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{m}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt =$$

$$\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\Bigg\{\int_{-\infty}^{t}\Big\{nmH(s)H(t)+2m(m-1)H(s)^2H(t)+2m(n-1)H(s)H(t)^2$$
$$+m(m-1)(n-2)H(s)^2H(t)+m(n-1)(n-2)H(s)H(t)^2$$
$$+2m(m-1)H(t)^2H(s)^2+4m(m-1)(n-2)H(t)^2H(s)^2$$
$$+m(m-1)(n-2)(n-3)H(t)^2H(s)^2\Big\}ds$$
$$\int_{t}^{\infty}\Big\{nmH(s)H(t)+2m(m-1)H(s)^2H(t)+2m(n-1)H(s)H(t)^2$$
$$+m(m-1)(n-2)H(s)^2H(t)+m(n-1)(n-2)H(s)H(t)^2$$
$$+2m(m-1)H(t)^2H(s)^2+4m(m-1)(n-2)H(t)^2H(s)^2$$
$$+m(m-1)(n-2)(n-3)H(t)^2H(s)^2\Big\}ds\Bigg\}dt.$$

Next, the fourth term in equation (3) can be calculated as

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}-\frac{2}{n^3m}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]ds\ dt =$$

$$-\frac{2}{n^3m}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{E}\left[1^2_{\{x_i\le s\}}1_{\{x_i\le t\}}1_{\{y_i\le t\}}\right]+m(n-1)\mathrm{E}\left[1^2_{\{x_i\le s\}}1_{\{x_i\le t\}}1_{\{y_j\le t\}}\right]$$
$$+m(n-1)\mathrm{E}\left[1^2_{\{x_i\le s\}}1_{\{y_i\le t\}}1_{\{x_j\le t\}}\right]+2m(n-1)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{x_i\le t\}}1_{\{y_i\le t\}}1_{\{x_j\le s\}}\right]$$
$$+m(n-1)\mathrm{E}\left[1^2_{\{x_i\le s\}}1_{\{x_j\le t\}}1_{\{y_j\le t\}}\right]+2m(n-1)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{x_i\le t\}}1_{\{x_j\le s\}}1_{\{y_j\le t\}}\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1^2_{\{x_i\le s\}}1_{\{x_j\le t\}}1_{\{y_k\le t\}}\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{x_i\le t\}}1_{\{x_j\le s\}}1_{\{y_k\le t\}}\right]$$
$$+3m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{y_i\le t\}}1_{\{x_j\le s\}}1_{\{x_k\le t\}}\right]$$
$$+m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{x_j\le s\}}1_{\{x_k\le t\}}1_{\{y_l\le t\}}\right]\Big\}ds\ dt. \quad (7)$$

Now, equation (7) is equivalent to

$$
\begin{aligned}
&-\frac{2}{n^3m}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]ds\;dt = \\
&\quad -\frac{2}{n^3m}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_i\le t\} \\
&\quad + m(n-1)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le t\} \\
&\quad + m(n-1)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_j\le t\} \\
&\quad + 2m(n-1)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{X_j\le s\} \\
&\quad + m(n-1)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_j\le t\} \\
&\quad + 2m(n-1)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_j\le t\} \\
&\quad + m(n-1)(n-2)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_k\le t\} \\
&\quad + 2m(n-1)(n-2)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_k\le t\} \\
&\quad + 3m(n-1)(n-2)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{X_k\le t\} \\
&\quad + m(n-1)(n-2)(n-3)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{X_k\le t\}\,\mathrm{pr}\{Y_l\le t\}\Big\}ds\;dt,
\end{aligned}
$$

which, under the null hypothesis, is equivalent to

$$
\begin{aligned}
&-\frac{2}{n^3m}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}-2\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]ds\;dt = \\
&\int_{-\infty}^{\infty}\left\{\int_{t}^{\infty}\Big\{mnH(s)H(t)+2m(n-1)H(s)H(t)^2+m(n-1)(n-2)H(s)H(t)^2\right. \\
&\qquad + 4m(n-1)H(s)^2H(t)+2m(n-1)(n-2)H(s)^2H(t) \\
&\qquad \left. + 3m(n-1)(n-2)H(s)^2H(t)^2+m(n-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\right\} \\
&\quad + \int_{-\infty}^{t}\Big\{mnH(t)^2+6m(n-1)H(s)H(t)^2+3m(n-1)(n-2)H(s)H(t)^2 \\
&\qquad + 3m(n-1)(n-2)H(s)^2H(t)^2+m(n-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\Big\}dt.
\end{aligned}
$$

Next, the fifth term in equation (3) can be calculated as

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\frac{4}{n^2m^2}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt =$$
$$\frac{4}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le t\}}1_{\{x_i\le s\}}1_{\{y_i\le s\}}\right]$$
$$+m(m-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le t\}}1_{\{x_i\le s\}}1_{\{y_j\le s\}}\right]$$
$$+m(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{x_j\le s\}}\right]$$
$$+m(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_j\le s\}}1_{\{y_j\le s\}}\right]$$
$$+m(m-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{y_i\le s\}}1_{\{y_j\le t\}}\right]$$
$$+m(m-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le t\}}1_{\{x_j\le s\}}1_{\{y_j\le s\}}\right]$$
$$+m(n-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{y_j\le t\}}1_{\{y_j\le s\}}\right]$$
$$+m(m-1)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le s\}}1_{\{y_j\le t\}}1_{\{x_j\le s\}}\right]$$
$$+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le t\}}1_{\{x_j\le s\}}1_{\{y_k\le s\}}\right]$$
$$+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_k\le s\}}\right]$$
$$+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_i\le s\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{x_j\le s\}}1_{\{y_k\le t\}}1_{\{y_k\le s\}}\right]$$
$$+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_i\le s\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}\right]$$
$$+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le s\}}1_{\{y_k\le t\}}1_{\{x_k\le s\}}\right]$$
$$+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right]\Big\}ds\ dt. \tag{8}$$

Now, equation (8) is equivalent to

$$\frac{4}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt =$$

$$\begin{aligned}
&\frac{4}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_i\le \min(s,t)\}\\
&+m(m-1)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_j\le s\}\\
&+m(n-1)\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le s\}\\
&+m(n-1)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_i\le s\}\\
&+m(m-1)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le s\}\\
&+m(m-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_j\le s\}\\
&+m(n-1)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le \min(s,t)\}\\
&+m(m-1)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_j\le s\}\\
&+m(m-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_k\le s\}\\
&+m(m-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_k\le s\}\,\mathrm{pr}\{Y_k\le s\}\\
&+m(m-1)(n-2)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_k\le s\}\\
&+m(n-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_k\le \min(s,t)\}\\
&+m(m-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_k\le s\}\\
&+m(m-1)(n-2)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_k\le t\}\,\mathrm{pr}\{X_k\le s\}\\
&+m(m-1)(n-2)(n-3)\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_k\le s\}\,\mathrm{pr}\{Y_l\le s\}\Big\}ds\ dt,
\end{aligned}$$

which, under the null hypothesis, is equivalent to

$$\frac{4}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt =$$

$$\begin{aligned}
&\int_{-\infty}^{\infty}\Bigg\{\int_{t}^{\infty}\Big\{nmH(s)^2+2m(n-1)H(s)^2H(t)+2m(m-1)H(s)^2H(t)\\
&\quad+2m(m-1)H(s)^2H(t)^2+m(n-1)(n-2)H(s)^2H(t)+m(m-1)(n-2)H(s)^2H(t)\\
&\quad+4m(m-1)(n-2)H(s)^2H(t)^2+m(m-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\Bigg\}\\
&+\int_{-\infty}^{\infty}\Bigg\{\int_{t}^{\infty}\Big\{nmH(t)^2+2m(n-1)H(s)H(t)^2+2m(m-1)H(s)H(t)^2\\
&\quad+2m(m-1)H(s)^2H(t)^2+m(n-1)(n-2)H(s)H(t)^2+m(m-1)(n-2)H(s)H(t)^2\\
&\quad+4m(m-1)(n-2)H(s)^2H(t)^2+m(m-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\Bigg\}dt.
\end{aligned}$$

Next, the sixth term in equation (3) can be calculated as

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} -\frac{2}{nm^3}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m} \mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right] ds\ dt =$$

$$\begin{aligned}
&-\frac{2}{nm^3}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{E}\left[1^2_{\{y_i\le s\}}1_{\{y_i\le t\}}1_{\{x_i\le t\}}\right] + m(n-1)\mathrm{E}\left[1^2_{\{y_i\le s\}}1_{\{y_i\le t\}}1_{\{x_j\le t\}}\right]\\
&+ m(m-1)\mathrm{E}\left[1^2_{\{y_i\le s\}}1_{\{x_i\le t\}}1_{\{y_j\le t\}}\right] + 2m(m-1)\mathrm{E}\left[1_{\{y_i\le s\}}1_{\{y_i\le t\}}1_{\{x_i\le t\}}1_{\{y_j\le s\}}\right]\\
&+ m(m-1)\mathrm{E}\left[1^2_{\{y_i\le s\}}1_{\{y_j\le t\}}1_{\{x_j\le t\}}\right] + 2m(m-1)\mathrm{E}\left[1_{\{y_i\le s\}}1_{\{y_i\le t\}}1_{\{y_j\le s\}}1_{\{x_j\le t\}}\right]\\
&+ m(m-1)(n-2)\mathrm{E}\left[1^2_{\{y_i\le s\}}1_{\{y_j\le t\}}1_{\{x_k\le t\}}\right]\\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\le s\}}1_{\{y_i\le t\}}1_{\{y_j\le s\}}1_{\{x^1_k\le t\}}\right]\\
&+ 3m(m-1)(m-2)\mathrm{E}\left[1_{\{y_i\le s\}}1_{\{x_i\le t\}}1_{\{y_j\le s\}}1_{\{y_k\le t\}}\right]\\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i\le s\}}1_{\{y_j\le s\}}1_{\{y_k\le t\}}1_{\{x_l\le t\}}\right]\Big\} ds\ dt.
\end{aligned} \tag{9}$$

Now, equation (9) is equivalent to

$$-\frac{2}{nm^3}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m} \mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right] ds\ dt =$$

$$\begin{aligned}
&-\frac{2}{nm^3}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{pr}\{X^1_i\le \min(s,t)\}\,\mathrm{pr}\{Y_i\le t\}\\
&+ m(n-1)\mathrm{pr}\{X_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le t\}\\
&+ m(m-1)\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{X_j\le t\}\,\mathrm{pr}\{Y_j\le t\}\\
&+ 2m(m-1)\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_j\le s\}\\
&+ m(m-1)\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_j\le t\}\\
&+ 2m(m-1)\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{X_j\le t\}\\
&+ m(m-1)(n-2)\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_k\le t\}\\
&+ 2m(m-1)(n-2)\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{X_k\le t\}\\
&+ 3m(m-1)(m-2)\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{X_i\le t\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{Y_k\le t\}\\
&+ m(m-1)(m-2)(n-3)\mathrm{pr}\{Y_i\le s\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{Y_k\le t\}\,\mathrm{pr}\{X_l\le t\}\Big\} ds\ dt,
\end{aligned}$$

which, under the null hypothesis, is equivalent to

$$-\frac{2}{nm^3}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m} \mathrm{E}\left[1_{\{x_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right] ds\ dt =$$

$$\begin{aligned}
&-\frac{2}{nm^3}\int_{-\infty}^{\infty}\Bigg\{\int_{t}^{\infty}\Big\{mnH(s)H(t) + 2m(m-1)H(s)H(t)^2\\
&\quad + m(m-1)(n-2)H(s)H(t)^2 + 2m(m-1)(n-2)H(s)^2H(t)\\
&\quad + 3m(m-1)(m-2)H(s)^2H(t)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)^2\Big\}ds\Bigg\}\\
&+ \int_{-\infty}^{t}\Big\{mnH(t)^2 + 6m(m-1)H(s)H(t)^2 + 3m(m-1)(n-2)H(s)H(t)^2\\
&\quad + 3m(m-1)(m-2)H(s)^2H(t)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)^2\Big\}ds\Bigg\}dt.
\end{aligned}$$

Next, the seventh term in equation (3) can be calculated as

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\frac{1}{n^2m^2}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]ds\ dt =$$

$$\begin{aligned}
&\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{E}\left[1^2_{\{x_i\le s\}}1^2_{\{y_i\le t\}}\right]+2m(m-1)\mathrm{E}\left[1^2_{\{x_i\le s\}}1_{\{y_i\le t\}}1_{\{y_j\le t\}}\right]\\
&+2m(n-1)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{x_j\le s\}}1^2_{\{y_j\le t\}}\right]+m(n-1)\mathrm{E}\left[1^2_{\{x_i\le s\}}1^2_{\{y_j\le t\}}\right]\\
&+2m(m-1)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{y_i\le t\}}1_{\{x_j\le s\}}1_{\{y_j\le s\}}\right] \qquad (10)\\
&+m(m-1)(n-2)\mathrm{E}\left[1^2_{\{x_i\le s\}}1_{\{y_j\le t\}}1_{\{y_k\le t\}}\right]\\
&+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{x_j\le s\}}1^2_{\{y_k\le t\}}\right]\\
&+4m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{y_i\le t\}}1_{\{x_j\le s\}}1_{\{y_k\le t\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\le s\}}1_{\{x_j\le s\}}1_{\{y_k\le t\}}1_{\{y_l\le t\}}\right]\Big\}ds\ dt. \qquad (11)
\end{aligned}$$

Now, equation (11) is equivalent to

$$\begin{aligned}
&\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]ds\ dt =\\
&\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_i\le t\}+2m(m-1)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le t\}\\
&+2m(n-1)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_j\le t\}+m(n-1)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_j\le t\}\\
&+2m(n-1)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_j\le t\}\\
&+m(m-1)(n-2)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_k\le t\}\\
&+m(n-1)(n-2)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_k\le t\}\\
&+4m(m-1)(n-2)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_k\le t\}\\
&+m(m-1)(n-2)(n-3)\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_k\le t\}\,\mathrm{pr}\{Y_l\le t\}\Big\}ds\ dt,
\end{aligned}$$

which, under the null hypothesis, is equivalent to

$$\begin{aligned}
&\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{x_l\le s\}}\right]ds\ dt =\\
&\frac{1}{n^2m^2}\int_{-\infty}^{\infty}\Bigg\{\int_{-\infty}^{t}\Big\{mnH(s)H(t)+2m(m-1)H(s)H(t)^2+2m(n-1)H(s)^2H(t)\\
&+2m(m-1)H(s)^2H(t)^2+m(m-1)(n-2)H(s)H(t)^2+m(n-1)(n-2)H(s)^2H(t)\\
&+4m(m-1)(n-2)H(s)^2H(t)^2+m(m-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\\
&+\int_{-\infty}^{t}\Big\{mnH(s)H(t)+2m(m-1)H(s)H(t)^2+2m(n-1)H(s)^2H(t)\\
&+2m(m-1)H(s)^2H(t)^2+m(m-1)(n-2)H(s)H(t)^2+m(n-1)(n-2)H(s)^2H(t)\\
&+4m(m-1)(n-2)H(s)^2H(t)^2+m(m-1)(n-2)(n-3)H(s)^2H(t)^2\Big\}ds\Bigg\}dt.
\end{aligned}$$

Next, the eighth term in equation (3) can be calculated as

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} -\frac{2}{nm^3}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m} \mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right] ds\ dt =$$
$$-\frac{2}{nm^3}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{E}\left[1^2_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{x_i\le s\}}\right] + m(n-1)\mathrm{E}\left[1^2_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{x_j\le s\}}\right]$$
$$+ m(m-1)\mathrm{E}\left[1^2_{\{y_i\le t\}}1_{\{x_i\le s\}}1_{\{y_j\le s\}}\right] + 2m(m-1)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{x_i\le s\}}1_{\{y_j\le t\}}\right]$$
$$+ m(m-1)\mathrm{E}\left[1^2_{\{y_i\le t\}}1_{\{y_j\le s\}}1_{\{x_j\le s\}}\right] + 2m(m-1)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{y_j\le t\}}1_{\{x_j\le s\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1^2_{\{y_i\le t\}}1_{\{y_j\le s\}}1_{\{x_k\le s\}}\right]$$
$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}\right]$$
$$+ 3m(m-1)(m-2)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{x_i\le s\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}\right]$$
$$+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{x_l\le s\}}\right]\Big\} ds\ dt. \tag{12}$$

Now, equation (12) is equivalent to

$$-\frac{2}{nm^3}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m} \mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right] ds\ dt =$$
$$-\frac{2}{nm^3}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{X_i\le s\}$$
$$+ m(n-1)\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{X_j\le s\}$$
$$+ m(m-1)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{X_j\le s\}\,\mathrm{pr}\{Y_j\le s\}$$
$$+ 2m(m-1)\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_j\le t\}$$
$$+ m(m-1)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{X_j\le s\}$$
$$+ 2m(m-1)\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_j\le s\}$$
$$+ m(m-1)(n-2)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{X_k\le s\}$$
$$+ 2m(m-1)(n-2)\mathrm{pr}\{Y_i\le \min(s,t)\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{X_k\le s\}$$
$$+ 3m(m-1)(m-2)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{X_i\le s\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_k\le s\}$$
$$+ m(m-1)(m-2)(n-3)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_k\le s\}\,\mathrm{pr}\{X_l\le s\}\Big\} ds\ dt,$$

which, under the null hypothesis, is equivalent to

$$-\frac{2}{nm^3}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m} \mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{x_k\le s\}}1_{\{y_l\le s\}}\right] ds\ dt =$$
$$-\frac{2}{nm^3}\int_{-\infty}^{\infty}\Bigg\{\int_{-\infty}^{t}\Big\{mnH(s)^2 + 6m(m-1)H(s)^2H(t) + 3m(m-1)(n-2)H(s)^2H(t)$$
$$+ 3m(m-1)(m-2)H(s)^2H(t)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)^2\Big\}ds$$
$$+ \int_{t}^{\infty}\Big\{mnH(s)H(t) + 2m(m-1)H(s)^2H(t)$$
$$+ 4m(m-1)H(s)H(t)^2 + m(m-1)(n-2)H(s)^2H(t) + 2m(m-1)(n-2)H(s)H(t)^2$$
$$+ 3m(m-1)(m-2)H(s)^2H(t)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)^2\Big\}ds\Bigg\}dt.$$

Next, the ninth term in equation (3) can be calculated as

$$
\begin{aligned}
&\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\frac{1}{m^4}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt = \\
&\quad \frac{1}{m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{E}\left[1^2_{\{y_i\le t\}}1^2_{\{y_i\le s\}}\right] + 2m(m-1)\mathrm{E}\left[1^2_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{y_j\le s\}}\right] \\
&\quad + 2m(m-1)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1^2_{\{y_i\le s\}}\right] + m(m-1)\mathrm{E}\left[1^2_{\{y_i\le t\}}1^2_{\{y_j\le s\}}\right] \\
&\quad + 2m(m-1)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{y_j\le t\}}1_{\{y_i\le s\}}\right] \\
&\quad + m(m-1)(m-2)\mathrm{E}\left[1^2_{\{y_i\le t\}}1_{\{y_j\le s\}}1_{\{y_k\le s\}}\right] \\
&\quad + m(m-1)(m-2)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1^2_{\{y_k\le s\}}\right] \\
&\quad + 4m(m-1)(m-2)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_i\le s\}}1_{\{y_j\le s\}}1_{\{y_k\le t\}}\right] \\
&\quad + m(m-1)(m-2)(m-3)\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right]\Big\}ds\ dt. \qquad (13)
\end{aligned}
$$

Now, equation (13) is equivalent to

$$
\begin{aligned}
&\frac{1}{m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt = \\
&\quad \frac{1}{m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\Big\{m\mathrm{pr}\{Y_i\le\min(s,t)\} + 2m(m-1)\mathrm{pr}\{Y_i\le\min(s,t)\}\,\mathrm{pr}\{Y_i\le s\} \\
&\quad + 2m(m-1)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le\min(s,t)\} + m(m-1)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le s\} \\
&\quad + 2m(m-1)\mathrm{pr}\{Y_i\le\min(s,t)\}\,\mathrm{pr}\{Y_j\le\min(s,t)\} \\
&\quad + m(m-1)(m-2)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le s\}\,\mathrm{pr}\{Y_k\le s\} \\
&\quad + m(m-1)(m-2)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_k\le s\} \\
&\quad + 4m(m-1)(m-2)\mathrm{pr}\{Y_i\le\min(s,t)\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_k\le s\} \\
&\quad + m(m-1)(m-2)(m-3)\mathrm{pr}\{Y_i\le t\}\,\mathrm{pr}\{Y_j\le t\}\,\mathrm{pr}\{Y_k\le s\}\,\mathrm{pr}\{Y_l\le s\}\Big\}ds\ dt,
\end{aligned}
$$

which, under the null hypothesis, is equivalent to

$$
\begin{aligned}
&\frac{1}{m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m}\mathrm{E}\left[1_{\{y_i\le t\}}1_{\{y_j\le t\}}1_{\{y_k\le s\}}1_{\{y_l\le s\}}\right]ds\ dt = \\
&\quad \frac{1}{m^4}\int_{-\infty}^{\infty}\Bigg\{\int_{-\infty}^{t}\Big\{mH(s) + 4m(m-1)H(s)^2 + 3m(m-1)H(s)H(t) \\
&\qquad + 5m(m-1)(m-2)H(s)^2H(t) + m(m-1)(m-2)H(s)H(t)^2 \\
&\qquad + m(m-1)(m-2)(m-3)H(s)^2H(t)^2\Big\}ds \\
&\quad + \int_{t}^{\infty}\Big\{mH(t) + 4m(m-1)H(t)^2 + 3m(m-1)H(s)H(t) \\
&\qquad + m(m-1)(m-2)H(s)^2H(t) + 5m(m-1)(m-2)H(s)H(t)^2 \\
&\qquad + m(m-1)(m-2)(m-3)H(s)^2H(t)^2\Big\}ds\Bigg\}dt.
\end{aligned}
$$

Collecting all the calculated terms from equation (3), we get

$$
\begin{aligned}
\mathrm{E}[T_{n,m}^2] = \int_{-\infty}^{\infty} \Bigg\{ \int_{-\infty}^{t} \Bigg\{ & \frac{2(n^3+m^3)}{nm(n+m)^2} H(s) + \left(4 - \frac{8(n^3+m^3)}{nm(n+m)^3}\right) H(s)^2 \\
& + \left(2 - \frac{6(n^3+m^3)}{nm(n+m)^2}\right) H(s)H(t) - \left(10 - \frac{20(n^3+m^3)}{nm(n+m)^2}\right) H(s)^2 H(t) \\
& - \left(2 - \frac{4(n^3+m^3)}{nm(n+m)^2}\right) H(s)H(t)^2 \\
& + \left(6 - \frac{12(n^3+m^3)}{nm(n+m)^2}\right) H(s)^2 H(t)^2 \Bigg\} ds \Bigg\} dt.
\end{aligned} \tag{14}
$$

Now, from Proposition 1,

$$
\mathrm{E}[T_{n,m}] = \int_{-\infty}^{\infty} \left(H(t) - H(t)^2\right) dt,
$$

and thus

$$
\begin{aligned}
\{\mathrm{E}[T_{n,m}]\}^2 &= \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} H(t)(1-H(t))H(s)(1-H(s)) ds\ dt \\
&= 2 \int_{-\infty}^{\infty} \int_{-\infty}^{t} H(s)H(t)(1-H(s))(1-H(t)) ds\ dt \\
&= 2 \int_{-\infty}^{\infty} \int_{-\infty}^{t} \left(H(s)H(t) - H(s)H(t)^2 - H(s)^2H(t) + H(s)^2H(t)^2\right) ds\ dt.
\end{aligned} \tag{15}
$$

Collecting together equations (14) and (15) we get

$$
\begin{aligned}
\mathrm{Var}[T_{n,m}] = & \int_{-\infty}^{\infty} \int_{-\infty}^{t} \frac{2(n^3+m^3)}{nm(n+m)^2} H(s) \\
& + \left(4 - \frac{8(n^3+m^3)}{nm(n+m)^2}\right) H(s)^2 - \frac{6(n^3+m^3)}{nm(n+m)^2} H(s)H(t) - \left(8 - \frac{20(n^3+m^3)}{nm(n+m)^2}\right) H(s)^2 H(t) \\
& + \frac{4(n^3+m^3)}{nm(n+m^2)} H(s)H(t)^2 + \left(4 - \frac{12(n^3+m^3)}{nm(n+m)^2}\right) H(s)^2H(t)^2 ds\ dt,
\end{aligned}
$$

which can be factorized to give

$$
\begin{aligned}
\mathrm{Var}[T_{n,m}] = & \frac{2(n^3+m^3)}{nm(n+m)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{t} H(s) \Bigg(1 + 2\left(\frac{nm(n+m)^2}{n^3+m^3} - 2\right) H(s) - 3H(t) \\
& - 2\left(\frac{2nm(n+m)^2}{n^3+m^3} - 5\right) H(s)H(t) + 2H(t)^2 + 2\left(\frac{nm(n+m)^2}{n^3+m^3} - 3\right) H(s)H(t)^2 \Bigg) ds\ dt.
\end{aligned}
$$

□

Proposition 3 The third moment of the test statistic $T_{n,m}$ where $n > m$ follows the following formula;

$$
\begin{aligned}
\mathrm{E}[T^3_{n,m}|F=G] = &\frac{6(n^5+m^5)}{(n+m)^3(nm)^2}\int_{-\infty}^{\infty}\int_{-\infty}^{r}\int_{-\infty}^{s} H(t)\Bigg(1 \\
&+2\left(\frac{nm(n+m)^2(7m^2-10nm+7n^2)}{n^5+m^5}-8\right)H(t) \\
&+2\left(\frac{nm(n+m)^2(5m^2-7nm+5n^2)}{n^5+m^5}-6\right)H(s)+\left(\frac{nm(n+m)^2(m^2-nm+n^2)}{n^5+m^5}-3\right)H(r) \\
&+5\left(\frac{nm(n+m)^2(2m^2n+2mn^2-19m^2+25mn-19n^2)}{n^5+m^5}+18\right)H(s)H(t) \\
&+\left(\frac{nm(n+m)^2(2m^2n+2mn^2-19m^2+25mn-19n^2)}{n^5+m^5}+18\right)H(s)^2 \\
&-\left(\frac{nm(n+m)^2(m^2-nm+n^2)}{n^5+m^5}-2\right)H(r)^2 \\
&+2\left(\frac{nm(n+m)^2(m^2n+mn^2-19m^2+26mn-19n^2)}{n^5+m^5}+20\right)H(r)H(t) \\
&+\left(\frac{nm(n+m)^2(m^2n+mn^2-27m^2+37mn-27n^2)}{n^5+m^5}+30\right)H(r)H(s) \\
&-4\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5}+24\right)H(s)^2H(t) \\
&-5\left(\frac{nm(n+m)^2(5m^2n+5mn^2-45m^2+59mn-49n^2)}{n^5+m^5}+42\right)H(r)H(s)H(t) \\
&-2\left(\frac{nm(n+m)^2(m^2n+mn^2-12m^2+16mn-12n^2)}{n^5+m^5}+12\right)H(r)^2H(t) \\
&-\left(\frac{nm(n+m)^2(5m^2n+5mn^2-45m^2+59mn-49n^2)}{n^5+m^5}+42\right)H(r)H(s)^2 \\
&-\left(\frac{nm(n+m)^2(m^2n+mn^2-17m^2+23mn-17n^2)}{n^5+m^5}+18\right)H(r)^2H(s) \\
&+9\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5}+24\right)H(r)H(s)^2H(t) \\
&+5\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5}+24\right)H(r)^2H(s)H(t) \\
&+\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5}+24\right)H(r)^2H(s)^2 \\
&-5\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5}+24\right)H(r)^2H(s)^2H(t)\Bigg)dr\ ds\ dt. \quad (16)
\end{aligned}
$$

where $H(t)$ is the distribution of the two data sets under the null hypothesis.

Proof Consider the test statistic

$$A = \frac{nm}{n+m}\int_{-\infty}^{\infty}(\hat{F}(t)-\hat{G}(t))^2 ds.$$

To calculate the third non-centralised moment we need to calculate

$$\mathrm{E}[T_{n,m}^3] = \frac{n^3m^3}{(n+m)^3} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \mathrm{E}\left[\left(\hat{F}(s) - \hat{G}(s)\right)^2 \left(\hat{F}(t) - \hat{G}(t)\right)^2 \left(\hat{F}(u) - \hat{G}(u)\right)^2 \right] du\ dt\ ds$$

$$= \frac{n^3m^3}{(n+m)^3} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \mathrm{E}\Bigg[\tag{17}$$

$$\frac{1}{n^6} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{o=1}^{n} \sum_{p=1}^{n} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{x_p \geq u\}} \tag{18}$$

$$- \frac{2}{n^5m} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{o=1}^{n} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{y_p \geq u\}} \tag{19}$$

$$+ \frac{1}{n^4m^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{o=1}^{m} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{y_o \geq u\}} 1_{\{y_p \geq u\}} \tag{20}$$

$$- \frac{2}{n^5m} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} \sum_{l=1}^{m} \sum_{o=1}^{n} \sum_{p=1}^{n} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{x_p \geq u\}} \tag{21}$$

$$+ \frac{4}{n^4m^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{o=1}^{n} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{y_p \geq u\}} \tag{22}$$

$$- \frac{2}{n^3m^3} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} \sum_{l=1}^{m} \sum_{o=1}^{m} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{y_o \geq u\}} 1_{\{y_p \geq u\}} \tag{23}$$

$$+ \frac{1}{n^4m^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{m} \sum_{l=1}^{m} \sum_{o=1}^{n} \sum_{p=1}^{n} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{x_p \geq u\}} \tag{24}$$

$$- \frac{2}{n^3m^3} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{m} \sum_{l=1}^{m} \sum_{o=1}^{n} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{y_p \geq u\}} \tag{25}$$

$$+ \frac{1}{n^2m^4} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{m} \sum_{l=1}^{m} \sum_{o=1}^{m} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{y_o \geq u\}} 1_{\{y_p \geq u\}} \tag{26}$$

$$- \frac{2}{n^5m} \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{o=1}^{n} \sum_{p=1}^{n} 1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{x_p \geq u\}} \tag{27}$$

$$+ \frac{4}{n^4m^2} \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{o=1}^{n} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{y_p \geq u\}} \tag{28}$$

$$- \frac{2}{n^3m^3} \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{o=1}^{m} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{y_o \geq u\}} 1_{\{y_p \geq u\}} \tag{29}$$

$$+ \frac{4}{n^4m^2} \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{n} \sum_{l=1}^{m} \sum_{o=1}^{n} \sum_{p=1}^{n} 1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{x_p \geq u\}} \tag{30}$$

$$- \frac{8}{n^3m^3} \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{n} \sum_{l=1}^{m} \sum_{o=1}^{n} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{y_p \geq u\}} \tag{31}$$

$$+ \frac{4}{n^2m^4} \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{n} \sum_{l=1}^{m} \sum_{o=1}^{m} \sum_{p=1}^{m} 1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{y_o \geq u\}} 1_{\{y_p \geq u\}} \tag{32}$$

$$- \frac{2}{n^3m^3} \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{m} \sum_{l=1}^{m} \sum_{o=1}^{n} \sum_{p=1}^{n} 1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_o \geq u\}} 1_{\{x_p \geq u\}} \tag{33}$$

$$\tag{34}$$

$$+\frac{4}{n^2m^4}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{m}1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}} \tag{35}$$

$$-\frac{2}{nm^5}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m}\sum_{o=1}^{m}\sum_{p=1}^{m}1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_o\geq u\}}1_{\{y_p\geq u\}} \tag{36}$$

$$+\frac{1}{n^4m^2}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{n}\sum_{p=1}^{n}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_o\geq u\}}1_{\{x_p\geq u\}} \tag{37}$$

$$-\frac{2}{n^3m^3}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{n}\sum_{p=1}^{m}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}} \tag{38}$$

$$+\frac{1}{n^2m^4}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{m}\sum_{p=1}^{m}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{y_o\geq u\}}1_{\{y_p\geq u\}} \tag{39}$$

$$-\frac{2}{n^3m^3}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{n}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{x_p\geq u\}} \tag{40}$$

$$+\frac{4}{n^2m^4}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{m}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}} \tag{41}$$

$$-\frac{2}{nm^5}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m}\sum_{o=1}^{m}\sum_{p=1}^{m}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_o\geq u\}}1_{\{y_p\geq u\}} \tag{42}$$

$$+\frac{1}{n^2m^4}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{n}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{x_p\geq u\}} \tag{43}$$

$$-\frac{2}{nm^5}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{m}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}} \tag{44}$$

$$+\frac{1}{m^6}\sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m}\sum_{o=1}^{m}\sum_{p=1}^{m}1_{\{y_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_o\geq u\}}1_{\{y_p\geq u\}}\Bigg]. \tag{45}$$

It is important to note that we can split the triple integral into the sum of six triple integrals for the following six cases;

1. $s \geq t \geq u$,
2. $s \geq u \geq t$,
3. $t \geq s \geq u$,
4. $t \geq u \geq s$,
5. $u \geq s \geq t$,
6. $u \geq t \geq s$.

We also know that due to symmetry, all six triple integrals will be equal. Thus we will only consider the first scenario and multiply the result by six. Now, we can calculate the integral for each line in the above expectation separately. Equation (18) is equivalent to,

$$
\begin{aligned}
&\frac{1}{n^6}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{n}\sum_{p=1}^{n}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_o\geq u\}}1_{\{x_p\geq u\}}\right]\\
&\quad=\frac{1}{n^6}\Bigg\{n\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+2n(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2n(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+2n(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+n(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2{1_{\{x_j\geq u\}}}^2\right]\\
&\qquad+n(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_j\geq t\}}}^2{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+n(n-1)\mathrm{E}\left[{1_{\{x_j\geq s\}}}^2{1_{\{x_i\geq t\}}}^2{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+4n(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+4n(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+4n(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+4n(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2n(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_j\geq u\}}}^2\right]\\
&\qquad+2n(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2{1_{\{x_j\geq u\}}}^2\right]\\
&\qquad+2n(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_j\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+n(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&\qquad+n(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+n(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+4n(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&\qquad+4n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&\qquad+4n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\qquad+2n(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_k\geq u\}}}^2\right]\\
&\qquad+4n(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&\qquad+2n(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_k\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+4n(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2{1_{\{x_k\geq u\}}}^2\right]\\
&\qquad+4n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]
\end{aligned}
$$

$$+ 2n(n-1)(n-2)\mathrm{E}\left[1_{\{x_k\geq s\}}{}^2 1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}} 1_{\{x_j\geq u\}}\right]$$
$$+ 4n(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}} 1_{\{x_k\geq s\}} 1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}} 1_{\{x_j\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_k\geq t\}}{}^2 1_{\{x_i\geq u\}}{}^2\right]$$
$$+ 4n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_j\geq t\}} 1_{\{x_k\geq t\}} 1_{\{x_i\geq u\}}{}^2\right]$$
$$+ 2n(n-1)(n-2)\mathrm{E}\left[1_{\{x_k\geq s\}}{}^2 1_{\{x_i\geq t\}} 1_{\{x_j\geq t\}} 1_{\{x_i\geq u\}}{}^2\right]$$
$$+ 4n(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}} 1_{\{x_k\geq s\}} 1_{\{x_i\geq t\}} 1_{\{x_j\geq t\}} 1_{\{x_i\geq u\}}{}^2\right]$$
$$+ 8n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_i\geq t\}} 1_{\{x_j\geq t\}} 1_{\{x_i\geq u\}} 1_{\{x_k\geq u\}}\right]$$
$$+ 8n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_i\geq t\}} 1_{\{x_k\geq t\}} 1_{\{x_i\geq u\}} 1_{\{x_j\geq u\}}\right]$$
$$+ 8n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_k\geq s\}} 1_{\{x_i\geq t\}} 1_{\{x_j\geq t\}} 1_{\{x_i\geq u\}} 1_{\{x_j\geq u\}}\right]$$
$$+ n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}{}^2 1_{\{x_k\geq u\}}{}^2\right]$$
$$+ 2n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}} 1_{\{x_k\geq t\}} 1_{\{x_j\geq u\}} 1_{\{x_k\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}} 1_{\{x_k\geq s\}} 1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}} 1_{\{x_k\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}} 1_{\{x_k\geq s\}} 1_{\{x_j\geq t\}} 1_{\{x_k\geq t\}} 1_{\{x_i\geq u\}}{}^2\right]$$
$$+ 8n(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_i\geq t\}} 1_{\{x_k\geq t\}} 1_{\{x_j\geq u\}} 1_{\{x_k\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}} 1_{\{x_j\geq t\}} 1_{\{x_k\geq u\}} 1_{\{x_l\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_k\geq t\}} 1_{\{x_l\geq t\}} 1_{\{x_i\geq u\}} 1_{\{x_j\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_i\geq t\}}{}^2 1_{\{x_k\geq u\}} 1_{\{x_l\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}} 1_{\{x_l\geq s\}} 1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}} 1_{\{x_j\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_k\geq t\}} 1_{\{x_l\geq t\}} 1_{\{x_i\geq u\}}{}^2\right]$$
$$+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}} 1_{\{x_l\geq s\}} 1_{\{x_i\geq t\}} 1_{\{x_j\geq t\}} 1_{\{x_i\geq u\}}{}^2\right]$$
$$+ 8n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_i\geq t\}} 1_{\{x_k\geq t\}} 1_{\{x_i\geq u\}} 1_{\{x_l\geq u\}}\right]$$
$$+ n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}{}^2 1_{\{x_k\geq u\}} 1_{\{x_l\geq u\}}\right]$$
$$+ n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_k\geq t\}} 1_{\{x_l\geq t\}} 1_{\{x_j\geq u\}}{}^2\right]$$
$$+ n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}} 1_{\{x_l\geq s\}} 1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}{}^2\right]$$
$$+ 4n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}} 1_{\{x_k\geq t\}} 1_{\{x_j\geq u\}} 1_{\{x_l\geq u\}}\right]$$
$$+ 4n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}} 1_{\{x_k\geq s\}} 1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}} 1_{\{x_l\geq u\}}\right]$$
$$+ 4n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}} 1_{\{x_k\geq s\}} 1_{\{x_j\geq t\}} 1_{\{x_l\geq t\}} 1_{\{x_i\geq u\}}{}^2\right]$$
$$+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_i\geq t\}} 1_{\{x_j\geq t\}} 1_{\{x_k\geq u\}} 1_{\{x_l\geq u\}}\right]$$
$$+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}} 1_{\{x_j\geq s\}} 1_{\{x_k\geq t\}} 1_{\{x_l\geq t\}} 1_{\{x_i\geq u\}} 1_{\{x_j\geq u\}}\right]$$

$$
\begin{aligned}
&+ 2n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 8n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 8n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 8n(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ n(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_l\geq u\}}1_{\{x_o\geq u\}}\right]\\
&+ n(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_l\geq u\}}1_{\{x_o\geq u\}}\right]\\
&+ n(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_l\geq t\}}1_{\{x_o\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&+ 4n(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_l\geq u\}}1_{\{x_o\geq u\}}\right]\\
&+ 4n(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_l\geq t\}}1_{\{x_o\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 4n(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{x_o\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ n(n-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_o\geq u\}}1_{\{x_p\geq u\}}\right]\Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{1}{n^6}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} nH(u)+2n(n-1)H(u)^2+2n(n-1)H(t)H(u)+2n(n-1)H(s)H(u)\\
&\quad+n(n-1)H(t)H(u)+n(n-1)H(t)H(u)+n(n-1)H(s)H(u)+4n(n-1)H(u)^2\\
&\quad+4n(n-1)H(u)^2+4n(n-1)H(t)H(u)+4n(n-1)H(u)^2+2n(n-1)H(t)H(u)\\
&\quad+2n(n-1)H(t)H(u)+2n(n-1)H(u)^2+n(n-1)(n-2)H(t)H(u)^2\\
&\quad+n(n-1)(n-2)H(t)^2H(u)+n(n-1)(n-2)H(s)^2H(u)\\
&\quad+4n(n-1)(n-2)H(t)H(u)^2+4n(n-1)(n-2)H(s)H(u)^2\\
&\quad+4n(n-1)(n-2)H(s)H(t)H(u)+2n(n-1)(n-2)H(t)^2H(u)\\
&\quad+4n(n-1)(n-2)H(t)H(u)^2+2n(n-1)(n-2)H(t)H(u)^2\\
&\quad+4n(n-1)(n-2)H(t)H(u)^2+2n(n-1)(n-2)H(s)H(t)H(u)\\
&\quad+4n(n-1)(n-2)H(t)H(u)^2+2n(n-1)(n-2)H(s)H(u)^2\\
&\quad+4n(n-1)(n-2)H(s)H(u)^2+2n(n-1)(n-2)H(s)H(t)H(u)\\
&\quad+4n(n-1)(n-2)H(t)^2H(u)+2n(n-1)(n-2)H(s)H(t)H(u)\\
&\quad+4n(n-1)(n-2)H(s)H(t)H(u)+8n(n-1)(n-2)H(t)H(u)^2\\
&\quad+8n(n-1)(n-2)H(t)H(u)^2+8n(n-1)(n-2)H(s)H(u)^2\\
&\quad+n(n-1)(n-2)H(s)H(t)H(u)+2n(n-1)(n-2)H(s)H(u)^2\\
&\quad+2n(n-1)(n-2)H(t)H(u)^2+2n(n-1)(n-2)H(t)^2H(u)\\
&\quad+8n(n-1)(n-2)H(t)H(u)^2+2n(n-1)(n-2)(n-3)H(t)^2H(u)^2\\
&\quad+2n(n-1)(n-2)(n-3)H(t)^2H(u)^2+2n(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&\quad+2n(n-1)(n-2)(n-3)H(s)^2H(u)^2+2n(n-1)(n-2)(n-3)H(s)H(t)^2H(u)\\
&\quad+2n(n-1)(n-2)(n-3)H(s)^2H(t)H(u)+8n(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&\quad+n(n-1)(n-2)(n-3)H(s)H(t)H(u)^2+n(n-1)(n-2)(n-3)H(s)H(t)^2H(u)\\
&\quad+n(n-1)(n-2)(n-3)H(s)^2H(t)H(u)+4n(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&\quad+4n(n-1)(n-2)(n-3)H(s)H(t)H(u)^2+4n(n-1)(n-2)(n-3)H(s)H(t)^2H(u)\\
&\quad+2n(n-1)(n-2)(n-3)H(t)^2H(u)^2+2n(n-1)(n-2)(n-3)H(t)^2H(u)^2\\
&\quad+2n(n-1)(n-2)(n-3)H(s)^2H(u)^2+8n(n-1)(n-2)(n-3)H(t)^2H(u)^2\\
&\quad+8n(n-1)(n-2)(n-3)H(s)H(t)H(u)^2+8n(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&\quad+n(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&\quad+n(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&\quad+n(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)\\
&\quad+4n(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&\quad+4n(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&\quad+4n(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&\quad+n(n-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Thus the integral of equation (18) is equivalent to

$$\begin{aligned}
\frac{1}{n^6}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & nH(u) + 16n(n-1)H(u)^2 + 12n(n-1)H(t)H(u) \\
& + 3n(n-1)H(s)H(u) + 45n(n-1)(n-2)H(t)H(u)^2 + 9n(n-1)(n-2)H(t)^2H(u) \\
& + n(n-1)(n-2)H(s)^2H(u) + 20n(n-1)(n-2)H(s)H(u)^2 + 15n(n-1)(n-2)H(s)H(t)H(u) \\
& + 16n(n-1)(n-2)(n-3)H(t)^2H(u)^2 + 35n(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 \\
& + 4n(n-1)(n-2)(n-3)H(s)^2H(u)^2 + 7n(n-1)(n-2)(n-3)H(s)H(t)^2H(u) \\
& + 3n(n-1)(n-2)(n-3)H(s)^2H(t)H(u) + 9n(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
& + 5n(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2 \\
& + n(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u) \\
& + n(n-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}$$

Equation (19) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^5 m}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{n}\sum_{p=1}^{m}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}}\right]\\
&\quad=\frac{1}{n^6}\Bigg\{m\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_j\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_j\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+4m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_j\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_j\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]
\end{aligned}
$$

$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\,m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 {1_{\{x_k\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\,m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 {1_{\{x_k\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_k\geq u\}}1_{\{y_k\geq t\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\,m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 {1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\,m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 {1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_k\geq t\}}}^2 1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\,2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\,4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\,m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 {1_{\{x_j\geq t\}}}^2 1_{\{x_k\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\,m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\,m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\,m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]$$

$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}{1_{\{x_i \geq t\}}}^2 1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$

$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}{1_{\{x_i \geq t\}}}^2 1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{x_l \geq s\}}{1_{\{x_i \geq t\}}}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$

$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{x_l \geq s\}}{1_{\{x_i \geq t\}}}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{x_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_l \geq u\}}\right]$$

$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 {1_{\{x_j \geq t\}}}^2 1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_j \geq u\}}1_{\{y_j \geq u\}}\right]$$

$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{x_l \geq s\}}{1_{\{x_i \geq t\}}}^2 1_{\{x_j \geq u\}}1_{\{y_j \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}{1_{\{x_i \geq t\}}}^2 1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}{1_{\{x_i \geq t\}}}^2 1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_j \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{x_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right]$$

$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right]$$

$$
\begin{aligned}
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_j \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_j \geq t\}}1_{\{x_l \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{x_o \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{x_o \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_o \geq u\}}1_{\{y_p \geq u\}}\right] \Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{-2}{n^5 m}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(u)^2 + m(n-1)H(u)^2 + m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(s)H(u)^2 + m(n-1)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 + m(n-1)H(s)H(u)^2 \\
&\quad + 2m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 + 2m(n-1)H(s)H(u)^2 + 2m(n-1)H(t)H(u)^2 \\
&\quad + 4m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 + m(n-1)H(s)H(u)^2 + m(n-1)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(t)^2H(u)^2 + m(n-1)(n-2)H(s)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(n-1)(n-2)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(t)^2H(u)^2 + 4m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(t)^2H(u)^2 + 4m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(t)^2H(u)^2 + 4m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)(n-3)H(t)^2H(u)^2 \\
&\quad + m(n-1)(n-2)(n-3)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + m(n-1)(n-2)(n-3)H(s)^2H(u)^2 \\
&\quad + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)(n-3)H(t)^2H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 4m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2
\end{aligned}
$$

$$
\begin{aligned}
&+ 4m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ 4m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(n-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Thus the integral of equation (19) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^5m}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(u)^2 + 12mn(n-1)H(t)H(u)^2\\
&\quad + 3mn(n-1)H(s)H(u)^2 + mn(n-1)(n-2)H(s)^2H(u)^2 + 9mn(n-1)(n-2)H(t)^2H(u)^2\\
&\quad + 15mn(n-1)(n-2)H(s)H(t)H(u)^2 + 7mn(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&\quad + 3mn(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&\quad + mn(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Equation (20) is equivalent to,

$$
\begin{aligned}
&\frac{1}{n^4m^2}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{m}\sum_{p=1}^{m}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{y_o\geq u\}}1_{\{y_p\geq u\}}\right]\\
&\quad=\frac{1}{n^4m^2}\Bigg\{m\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+2m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2{1_{\{y_j\geq u\}}}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_j\geq t\}}}^2{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[{1_{\{x_j\geq s\}}}^2{1_{\{x_i\geq t\}}}^2{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+4m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+4m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+4m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+4m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_j\geq u\}}}^2\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2{1_{\{y_j\geq u\}}}^2\right]\\
&\qquad+2m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_j\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(m-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_i\geq t\}}}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+4m(m-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\qquad+4m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\qquad+4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_k\geq u\}}}^2\right]\\
&\qquad+4m(m-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\qquad+2m(m-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2{1_{\{x_k\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+4m(m-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2{1_{\{y_k\geq u\}}}^2\right]\\
&\qquad+4m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}}{}^2 1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ 4m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}}{}^2 1_{\{y_i \geq u\}}{}^2\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{y_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_i \geq u\}}{}^2\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_i \geq u\}}{}^2\right] \\
&+ 8m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_i \geq u\}} 1_{\{y_k \geq u\}}\right] \\
&+ 8m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_k \geq t\}} 1_{\{y_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ 8m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}}{}^2 1_{\{y_k \geq u\}}{}^2\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{y_j \geq u\}} 1_{\{y_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{y_j \geq u\}} 1_{\{y_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{y_i \geq u\}}{}^2\right] \\
&+ 8m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_k \geq t\}} 1_{\{y_j \geq u\}} 1_{\{y_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_k \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{y_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{y_k \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{y_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_i \geq u\}}{}^2\right] \\
&+ 8m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_k \geq t\}} 1_{\{y_i \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}}{}^2 1_{\{y_k \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{y_j \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{y_j \geq u\}}{}^2\right] \\
&+ 4m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{y_j \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 4m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{y_j \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_j \geq t\}} 1_{\{x_l \geq t\}} 1_{\{y_i \geq u\}}{}^2\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_k \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{x_l \geq t\}} 1_{\{y_i \geq u\}} 1_{\{y_j \geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{x_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 8m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 8m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 8m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_j \geq t\}}1_{\{x_l \geq t\}}1_{\{y_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{y_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}{1_{\{x_i \geq t\}}}^2 1_{\{y_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}{1_{\{y_i \geq u\}}}^2\right] \\
&+ 4m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ 4m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{y_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 4m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{x_o \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{y_o \geq u\}}1_{\{y_p \geq u\}}\right] \Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$\begin{aligned}
&\frac{1}{n^4m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(t)H(u) + 2m(m-1)H(t)H(u)^2 + 2m(n-1)H(t)^2H(u) \\
&\quad + 2m(n-1)H(s)H(t)H(u) + m(n-1)H(t)H(u) + m(n-1)H(s)H(t)H(u) \\
&\quad + m(n-1)H(s)H(t)H(u) + 4m(m-1)H(t)^2H(u)^2 + 4m(m-1)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)H(t)^2H(u) + 4m(m-1)H(t)^2H(u)^2 + 2m(n-1)H(t)^2H(u) \\
&\quad + 2m(n-1)H(s)H(t)H(u) + 2m(m-1)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(t)^2H(u) + m(n-1)(n-2)H(s)^2H(t)H(u) \\
&\quad + 4m(m-1)(n-2)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(t)^2H(u) \\
&\quad + 4m(m-1)(n-2)H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u) + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)H(s)^2H(t)H(u) \\
&\quad + 4m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 4m(n-1)(n-2)H(s)H(t)^2H(u) + 8m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 8m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 8m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(t)H(u) + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u) \\
&\quad + 8m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + 8m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u) \\
&\quad + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u) + 4m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 4m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u) \\
&\quad + 2m(m-1)(n-2)(n-3)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 + 8m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 8m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 8m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u) \\
&\quad + 4m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&\quad + 4m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&\quad + 4m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}$$

Thus the integral of equation (20) is equivalent to

$$\begin{aligned}
&\frac{1}{n^4m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u)+mn(m-1)H(t)H(u)^2+4mn(n-1)H(t)^2H(u)\\
&\quad+3mn(n-1)H(s)H(t)H(u)+4mn(m-1)(n-1)H(t)^2H(u)^2\\
&\quad+3mn(m-1)(n-1)H(s)H(t)H(u)^2+5mn(n-1)(n-2)H(s)H(t)^2H(u)\\
&\quad+mn(n-1)(n-2)H(s)^2H(t)H(u)+5mn(m-1)(n-1)(n-2)H(s)H(t)^2H(u)^2\\
&\quad+mn(m-1)(n-1)(n-2)H(s)^2H(t)H(u)^2\\
&\quad+mn(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u)\\
&\quad+mn(m-1)(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}$$

Equation (21) is equivalent to

$$\frac{-2}{n^5 m}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{n}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{x_p\geq u\}}\right]$$

$$\begin{aligned}
&= \frac{1}{n^6}\Bigg\{ m\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_j\geq u\}}}^2\right] \\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_j\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + 4m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_j\geq u\}}}^2\right] \\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_j\geq u\}}}^2\right] \\
&\quad + m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right] \\
&\quad + m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right] \\
&\quad + 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right] \\
&\quad + 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right]
\end{aligned}$$

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\begin{aligned}
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_k\geq u\}}}^2\right]\\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_k\geq u\}}}^2\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_k\geq u\}}}^2\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}{1_{\{x_j\geq u\}}}^2\right]\\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}{1_{\{x_i\geq u\}}}^2\right]
\end{aligned}
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\begin{aligned}
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{y_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_j \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_k \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{y_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_k \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_j \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_k \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{x_j \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_j \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_j \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{y_j \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_j \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_k \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_j \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_j \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_j \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_k \geq s\}} 1_{\{y_j \geq t\}} 1_{\{x_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right]
\end{aligned}
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\begin{aligned}
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_l \geq t\}}1_{\{y_o \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_l \geq t\}}1_{\{y_o \geq t\}}1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_l \geq t\}}1_{\{y_o \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{x_o \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{x_o \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_o \geq t\}}1_{\{y_p \geq t\}}1_{\{x_k \geq u\}}1_{\{x_l \geq u\}}\right]\Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{-2}{n^5 m}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(t)H(u) + m(n-1)H(t)H(u) + m(n-1)H(t)^2H(u) + 2m(n-1)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(s)H(t) + m(n-1)H(t)^2H(u) + m(n-1)H(t)^2H(u) \\
&\quad + m(n-1)H(s)H(t)H(u) + 2m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(s)H(t)H(u) + 2m(n-1)H(t)^2H(u) + 4m(n-1)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(t)^2H(u) + m(n-1)H(t)^2H(u) + m(n-1)H(s)H(t)H(u) \\
&\quad + m(n-1)(n-2)H(t)^2H(u) + m(n-1)(n-2)H(t)^2H(u)^2 + m(n-1)(n-2)H(s)^2H(t)H(u) \\
&\quad + 2m(n-1)(n-2)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u) + 2m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(n-1)(n-2)H(t)^2H(u) + m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 2m(n-1)(n-2)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(t)^2H(u) \\
&\quad + 2m(n-1)(n-2)H(s)H(t)^2H(u) + m(n-1)(n-2)H(s)H(t)H(u) \\
&\quad + m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(s)^2H(t)H(u) \\
&\quad + 2m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 4m(n-1)(n-2)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(t)^2H(u)^2 + 4m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(t)^2H(u)^2 + 4m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + m(n-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(t)^2H(u) + m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 2m(n-1)(n-2)H(t)^2H(u)^2 + 4m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(n-1)(n-2)(n-3)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u) + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u) \\
&\quad + m(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u) \\
&\quad + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u) + 2m(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) \\
&\quad + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + 4m(n-1)(n-2)(n-3)H(t)^2H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 4m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2
\end{aligned}
$$

$$
\begin{aligned}
&+ 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u) \\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ 4m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ m(n-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2 du\ dt\ ds
\end{aligned}
$$

Thus the integral of equation (21) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^5 m}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u) + 4mn(n-1)H(t)^2H(u) + 8mn(n-1)H(t)H(u)^2 \\
&\quad + 3mn(n-1)H(s)H(t)H(u) + 9mn(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + mn(n-1)(n-2)H(s)^2H(t)H(u) + 5mn(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 10mn(n-1)(n-2)H(s)H(t)H(u)^2 + 7mn(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + mn(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + 2mn(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + mn(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

Equation (22) is equivalent to

$$
\begin{aligned}
&\frac{4}{n^4m^2}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{m}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}}\right]\\
&= \frac{4}{n^4m^2}\Big\{m\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_j\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad + 2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad + 2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad + 2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + 2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(n-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad + m(m-1)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^21_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]
\end{aligned}
$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_i \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_i \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_k \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_k \geq u\}}\right]$$
$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_k \geq u\}}\right]$$
$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_i \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_i \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_k \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{y_j \geq u\}} 1_{\{x_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{y_j \geq u\}} 1_{\{x_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_k \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_k \geq t\}} 1_{\{y_k \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_j \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{x_j \geq t\}} 1_{\{y_k \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_j \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}{}^2 1_{\{y_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_j \geq u\}}\right]$$
$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_k \geq u\}} 1_{\{y_k \geq t\}}\right]$$
$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_k \geq u\}}\right]$$
$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{y_j \geq u\}} 1_{\{x_k \geq u\}}\right]$$
$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}}{}^2 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_j \geq u\}}\right]$$
$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{y_i \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right]$$

$$
\begin{aligned}
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_k \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[{1_{\{x_k \geq s\}}}^2 1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k \geq s\}}}^2 1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_j \geq t\}}1_{\{y_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{y_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_k\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_l\geq t\}}1_{\{y_o\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_l\geq t\}}1_{\{y_o\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_l\geq t\}}1_{\{y_o\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{x_o\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{x_o\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{x_o\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{x_o\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}}\right]\Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{4}{n^4m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(u)^2 + m(m-1)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 + m(m-1)H(t)H(u)^2 \\
&\quad + m(n-1)H(t)H(u)^2 + 2m(n-1)H(s)H(u)^2 + m(m-1)H(t)^2H(u)^2 \\
&\quad + m(m-1)H(t)^2H(u)^2 + 4m(n-1)H(s)H(u)^2 + m(n-1)H(u)^2 \\
&\quad + m(m-1)H(t)^2H(u)^2 + m(m-1)H(t)^2H(u)^2 + m(n-1)H(s)H(u)^2 \\
&\quad + 2m(m-1)H(s)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 + 2m(m-1)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(t)H(u)^2 + m(n-1)H(s)H(u)^2 + m(m-1)H(t)^2H(u)^2 \\
&\quad + m(m-1)H(t)^2H(u)^2 + m(n-1)H(s)H(u)^2 + m(n-1)H(t)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + 2m(m-1)H(t)^2H(u)^2 + m(n-1)H(t)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(n-1)(n-2)H(s)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(n-1)(n-2)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(s)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)^2H(u)^2 + m(n-1)(n-2)H(s)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2
\end{aligned}
$$

$$
\begin{aligned}
&+2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)(n-3)H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+2m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 + m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+m(n-1)(n-2)(n-3)H(s)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2du\ dt\ ds
\end{aligned}
$$

Thus the integral of equation (22) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^5m}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(u)^2 + mn(m+4n-5)H(t)H(u)^2 + 3mn(n-1)H(s)H(u)^2\\
&\quad+4mn(m-1)(n-1)H(t)^2H(u)^2 + mn(n-1)(3m+5n-13)H(s)H(t)H(u)^2\\
&\quad+mn(n-1)(n-2)H(s)^2H(u)^2 + 5mn(m-1)(n-1)(n-2)H(s)H(t)^2H(u)^2\\
&\quad+mn(n-1)(n-2)(n+m-4)H(s)^2H(t)H(u)^2\\
&\quad+mn(m-1)(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Equation (23) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^3m^3}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{m}\sum_{o=1}^{m}\sum_{p=1}^{m}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_o\geq u\}}1_{\{y_p\geq u\}}\right]\\
&\quad=\frac{1}{n^6}\Bigg\{m\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_j\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+4m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_j\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}{}^2\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]
\end{aligned}
$$

$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{y_k\geq u\}}}^2\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_k\geq u\}}}^2\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{y_k\geq u\}}}^2\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k\geq s\}}}^2 1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}{1_{\{y_j\geq u\}}}^2\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i\geq s\}}}^2 1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$

$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_j\geq u\}}{}^2\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^2 1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$

$$
\begin{aligned}
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \ge s\}}1_{\{x_k \ge s\}}1_{\{x_i \ge t\}}1_{\{y_j \ge t\}}1_{\{y_j \ge u\}}1_{\{y_l \ge u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \ge s\}}1_{\{x_k \ge s\}}1_{\{y_i \ge t\}}1_{\{x_j \ge t\}}1_{\{y_j \ge u\}}1_{\{y_l \ge u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \ge s\}}{}^2 1_{\{x_l \ge t\}}1_{\{y_o \ge t\}}1_{\{y_j \ge u\}}1_{\{y_k \ge u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \ge s\}}1_{\{x_k \ge s\}}1_{\{x_l \ge t\}}1_{\{y_o \ge t\}}1_{\{y_i \ge u\}}{}^2\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \ge s\}}1_{\{x_k \ge s\}}1_{\{x_i \ge t\}}1_{\{y_i \ge t\}}1_{\{y_l \ge u\}}1_{\{y_o \ge u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \ge s\}}1_{\{x_j \ge s\}}1_{\{x_l \ge t\}}1_{\{y_o \ge t\}}1_{\{y_i \ge u\}}1_{\{y_k \ge u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \ge s\}}1_{\{x_j \ge s\}}1_{\{x_i \ge t\}}1_{\{y_k \ge t\}}1_{\{y_l \ge u\}}1_{\{y_o \ge u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \ge s\}}1_{\{x_j \ge s\}}1_{\{y_i \ge t\}}1_{\{x_k \ge t\}}1_{\{y_l \ge u\}}1_{\{y_o \ge u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \ge s\}}1_{\{x_o \ge s\}}1_{\{x_i \ge t\}}1_{\{y_k \ge t\}}1_{\{y_i \ge u\}}1_{\{y_j \ge u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \ge s\}}1_{\{x_o \ge s\}}1_{\{y_i \ge t\}}1_{\{x_k \ge t\}}1_{\{y_i \ge u\}}1_{\{y_j \ge u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_i \ge s\}}1_{\{x_j \ge s\}}1_{\{x_o \ge t\}}1_{\{y_p \ge t\}}1_{\{y_k \ge u\}}1_{\{y_l \ge u\}}\right] \Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
\frac{4}{n^4m^2}&\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(t)H(u) + 2m(m-1)H(t)H(u)^2 + m(m-1)H(t)^2H(u) \\
&+ m(n-1)H(s)H(t)H(u) + 2m(n-1)H(s)H(t)H(u) + m(m-1)H(t)^2H(u) \\
&+ m(m-1)H(s)H(t)^2H(u) + m(n-1)H(s)H(t)H(u) + 2m(m-1)H(t)H(u)^2 \\
&+ 2m(m-1)H(s)H(t)H(u)^2 + 4m(m-1)H(s)H(t)H(u)^2 + 2m(m-1)H(s)H(t)^2H(u) \\
&+ 2m(n-1)H(s)H(t)H(u) + 2m(m-1)H(s)H(t)H(u)^2 + m(n-1)H(t)H(u) \\
&+ m(m-1)H(s)H(t)^2H(u) + 2m(m-1)H(s)H(t)^2H(u) + 2m(m-1)H(s)H(t)H(u)^2 \\
&+ m(m-1)(m-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u) \\
&+ m(n-1)(n-2)H(s)^2H(t)H(u) + 2m(m-1)(m-2)H(t)^2H(u)^2 \\
&+ 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&+ 2m(m-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(s)^2H(t)H(u) \\
&+ m(m-1)(n-2)H(t)^2H(u) + m(m-1)(n-2)H(s)H(t)^2H(u) \\
&+ 2m(m-1)(n-2)H(t)H(u)^2 + 2m(m-1)(m-2)H(s)H(t)^2H(u)^2 \\
&+ 2m(m-1)(m-2)H(s)H(t)^2H(u)^2 + 2m(m-1)(m-2)H(s)H(t)^2H(u)^2 \\
&+ 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(m-2)H(s)H(t)^2H(u)^2 \\
&+ 2m(m-1)(n-2)H(s)H(t)^2H(u) + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&+ 4m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)^2H(u) \\
&+ 2m(m-1)(n-2)H(s)H(t)^2H(u) + 2m(m-1)(n-2)H(s)^2H(t)^2H(u) \\
&+ m(m-1)(n-2)H(s)H(t)^2H(u) + m(n-1)(n-2)H(s)H(t)H(u) \\
&+ 2m(m-1)(n-2)H(s)^2H(t)^2H(u) + 2m(n-1)(n-2)H(s)H(t)H(u) \\
&+ 4m(m-1)(m-2)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&+ 4m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&+ 4m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&+ m(m-1)(n-2)H(s)H(t)^2H(u) + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&+ 2m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u) \\
&+ 4m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 \\
&+ m(m-1)(m-2)(n-3)H(t)^2H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&+ 2m(m-1)(m-2)(n-3)H(s)Ht)^2H(u)^2 + 2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u) \\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u) \\
&+ 4m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&+ m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)H(t)^2H(u) \\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + 2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&+ 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 \\
&+ 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u) + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u) \\
&+ 2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 \\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 4m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&+ 4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 + 4m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2
\end{aligned}
$$

$$
\begin{aligned}
&+4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+4m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+m(m-1)(m-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)\\
&+2m(m-1)(m-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+2m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+4m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+m(m-1)(m-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Thus the integral of equation (23) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u)+2mn(m-1)H(t)H(u)^2+mn(m-1)H(t)^2H(u)\\
&\quad+3mn(n-1)H(s)H(t)H(u)+3mn(m-1)(n-1)H(s)H(t)^2H(u)\\
&\quad+6mn(m-1)(n-1)H(s)H(t)H(u)^2+mn(m-1)(m-2)H(t)^2H(u)^2\\
&\quad+mn(n-1)(n-2)H(s)^2H(t)H(u)+3mn(m-1)(m-2)(n-1)H(s)H(t)^2H(u)^2\\
&\quad+2mn(m-1)(n-1)(n-2)H(s)^2H(t)H(u)^2+mn(m-1)(n-1)(n-2)H(s)^2H(t)^2H(u)\\
&\quad+mn(m-1)(m-2)(n-1)(n-2)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

The integral of equation (24) is equivalent to the integral of equation (20) but with t and u permuted. Thus the integral of equation (24) is equivalent to

$$
\begin{aligned}
&\frac{1}{n^4m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u)+mn(n-1)H(t)^2H(u)+4mn(n-1)H(t)H(u)^2\\
&\quad+3mn(n-1)H(s)H(t)H(u)+4mn(m-1)(n-1)H(t)^2H(u)^2\\
&\quad+3mn(m-1)(n-1)H(s)H(t)^2H(u)+5mn(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad+mn(n-1)(n-2)H(s)^2H(t)H(u)+5mn(m-1)(n-1)(n-2)H(s)H(t)^2H(u)^2\\
&\quad+mn(m-1)(n-1)(n-2)H(s)^2H(t)^2H(u)+mn(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&\quad+mn(m-1)(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Equation (25) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^3m^3}\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{m}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{m}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}}\right]\\
&=\frac{1}{n^6}\Bigg\{m\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}{}^21_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}{}^21_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_j\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}{}^21_{\{y_i\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}{}^21_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+4m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}{}^21_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_j\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_j\geq t\}}{}^21_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}{}^21_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\quad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\quad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&\quad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}{}^21_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\quad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}{}^21_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]
\end{aligned}
$$

$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_k \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 {1_{\{y_k \geq t\}}}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 {1_{\{y_k \geq t\}}}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_j \geq t\}}1_{\{y_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}{1_{\{y_i \geq t\}}}^2 1_{\{x_k \geq u\}}1_{\{y_k \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}{1_{\{y_i \geq t\}}}^2 1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}{1_{\{y_i \geq t\}}}^2 1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k \geq s\}}}^2 {1_{\{y_i \geq t\}}}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k \geq s\}}}^2 {1_{\{y_i \geq t\}}}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}{1_{\{y_i \geq t\}}}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}{1_{\{y_i \geq t\}}}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}{1_{\{y_k \geq t\}}}^2 1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_k \geq s\}}}^2 1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{y_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 {1_{\{y_j \geq t\}}}^2 1_{\{x_k \geq u\}}1_{\{y_k \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_j \geq t\}}1_{\{y_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right]$$
$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{x_k \geq s\}}{1_{\{y_i \geq t\}}}^2 1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right]$$

$$
\begin{aligned}
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} {1_{\{y_i \geq t\}}}^2 1_{\{y_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{y_j \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_i \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_k \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_k \geq t\}} 1_{\{y_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_k \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} {1_{\{y_i \geq t\}}}^2 1_{\{x_k \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} {1_{\{y_i \geq t\}}}^2 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} {1_{\{y_i \geq t\}}}^2 1_{\{y_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_i \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_i \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_k \geq t\}} 1_{\{y_i \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 {1_{\{y_j \geq t\}}}^2 1_{\{x_k \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} {1_{\{y_i \geq t\}}}^2 1_{\{x_j \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_j \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[{1_{\{x_i \geq s\}}}^2 1_{\{y_j \geq t\}} 1_{\{y_k \geq t\}} 1_{\{y_j \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} {1_{\{y_i \geq t\}}}^2 1_{\{x_j \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} {1_{\{y_i \geq t\}}}^2 1_{\{y_j \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{y_j \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_i \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_k \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_k \geq t\}} 1_{\{y_l \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{x_l \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{y_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_k \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_k \geq t\}} 1_{\{y_j \geq u\}} 1_{\{x_l \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_k \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{x_j \geq u\}} 1_{\{y_l \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{x_k \geq s\}} 1_{\{y_i \geq t\}} 1_{\{y_j \geq t\}} 1_{\{y_j \geq u\}} 1_{\{x_l \geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}{}^21_{\{y_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}{}^21_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_l\geq t\}}1_{\{y_o\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+4m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_l\geq t\}}1_{\{y_o\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_l\geq t\}}1_{\{y_o\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{x_o\geq s\}}1_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{x_o\geq s\}}1_{\{y_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+m(n-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}}\right]\Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(u)^2 + 2m(m-1)H(t)H(u)^2 + m(m-1)H(t)H(u)^2 \\
&\quad + m(n-1)H(s)H(u)^2 + 2m(n-1)H(s)H(u)^2 + m(m-1)H(t)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(n-1)H(s)H(u)^2 + 2m(m-1)H(t)H(u)^2 \\
&\quad + 2m(m-1)H(s)H(t)H(u)^2 + 4m(m-1)H(s)H(t)H(u)^2 + 2m(m-1)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(s)H(u)^2 + 4m(m-1)H(s)H(t)H(u)^2 + m(n-1)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + 2m(m-1)H(s)H(t)H(u)^2 + 2m(m-1)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(m-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)^2H(u)^2 + 2m(m-1)(m-2)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(t)H(u)^2 + 2m(m-1)(m-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(m-2)H(s)H(t)^2H(u)^2 + 2m(m-1)(m-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(m-2)H(s)H(u)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(u)^2 \\
&\quad + 4m(m-1)(m-2)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(m-1)(m-2)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + 4m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + 2mm-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)(n-3)H(t)^2H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(n-1)(n-2)(n-3)H(s)^2H(u)^2 \\
&\quad + 4m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 4m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 + 4m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2
\end{aligned}
$$

$$
\begin{aligned}
&+ 4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 + 4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 \\
&+ 4m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(m-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&+ m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)H(u)^2 \\
&+ 2m(m-1)(m-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&+ 2m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ 4m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ 2m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2 \\
&+ m(m-1)(m-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

Thus the integral of equation (25) is equivalent to

$$
\begin{aligned}
\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & mnH(u)^2 + 3mn(m-1)H(t)H(u)^2 + 3mn(n-1)H(s)H(u)^2 \\
&+ 9mn(m-1)(n-1)H(s)H(t)H(u)^2 + mn(m-1)(m-2)H(t)^2H(u)^2 \\
&+ mn(n-1)(n-2)H(s)^2H(t)^2 + 3mn(m-1)(m-2)(n-1)H(s)H(t)^2H(u)^2 \\
&+ 3mn(m-1)(n-1)(n-2)H(s)^2H(t)H(u)^2 \\
&+ mn(m-1)(m-2)(n-1)(n-2)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

The integral of equation (26) is equivalent to the integral of equation (24) but with s and t permuted and n and m permuted. Thus the integral of equation (24) is equivalent to

$$
\begin{aligned}
\frac{1}{n^2m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & mnH(s)H(u) + mn(m-1)H(s)^2H(u) + 4mn(m-1)H(s)H(u)^2 \\
&+ 3mn(m-1)H(s)H(t)H(u) + 4mn(m-1)(n-1)H(s)^2H(u)^2 \\
&+ 3mn(m-1)(n-1)H(s)^2H(t)H(u) + 5mn(m-1)(m-2)H(s)H(t)H(u)^2 \\
&+ mn(m-1)(m-2)H(s)H(t)^2H(u) + 5mn(m-1)(m-2)(n-1)H(s)^2H(t)H(u)^2 \\
&+ mn(m-1)(m-2)(n-1)H(s)^2H(t)^2H(u) + mn(m-1)(m-2)(m-3)H(s)H(t)^2H(u)^2 \\
&+ mn(m-1)(m-2)(m-3)(n-1)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

Equation (27) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^5 m}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{n}\sum_{p=1}^{n}\mathrm{E}\left[1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_o\geq u\}}1_{\{x_p\geq u\}}\right]\\
&\quad=\frac{1}{n^6}\Bigg\{m\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}{}^2 1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+4m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}{}^2\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}{}^2\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&\qquad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&\qquad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]
\end{aligned}
$$

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\begin{aligned}
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_i \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{y_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{y_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_k \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_k \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{y_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{y_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_k \geq t\}}{}^2 1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_k \geq t\}}{}^2 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}}{}^2\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_i \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq u\}}{}^2\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_i \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_i \geq s\}} 1_{\{x_k \geq t\}}{}^2 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_i \geq s\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_j \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}} 1_{\{y_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}} 1_{\{x_j \geq s\}} 1_{\{x_i \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}} 1_{\{x_j \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}} 1_{\{y_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{y_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j \geq s\}} 1_{\{x_k \geq s\}} 1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}} 1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}} 1_{\{y_k \geq s\}} 1_{\{x_j \geq t\}} 1_{\{x_k \geq t\}} 1_{\{x_i \geq u\}}{}^2\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}{}^2\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right] \\
&+ 4m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_o \geq s\}}1_{\{y_p \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_k \geq u\}}1_{\{x_l \geq u\}}\right] \Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{-2}{n^5 m}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(s)H(u) + m(n-1)H(s)H(u) + m(n-1)H(s)^2H(u)\\
&\quad + 2m(n-1)H(s)H(u)^2 + 2m(n-1)H(s)H(t)H(u) + m(n-1)H(s)^2H(u)\\
&\quad + m(n-1)H(s)H(t)H(u) + 2m(n-1)H(s)H(u)^2 + 2m(n-1)H(s)H(u)^2\\
&\quad + 2m(n-1)H(s)H(t)H(u) + 2m(n-1)H(s)H(t)H(u) + 4m(n-1)H(s)H(u)^2\\
&\quad + 2m(n-1)H(s)H(u)^2 + 2m(n-1)H(s)H(u)^2 + 2m(n-1)H(s)H(u)^2\\
&\quad + 2m(n-1)H(s)H(t)H(u) + m(n-1)H(s)H(t)H(u) + m(n-1)H(s)H(t)H(u)\\
&\quad + m(n-1)(n-2)H(s)^2H(u) + m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(s)H(u)^2\\
&\quad + 2m(n-1)(n-2)H(s)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)\\
&\quad + 2m(n-1)(n-2)H(s)^2H(t)H(u) + 4m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + 2m(n-1)(n-2)H(s)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(u)^2\\
&\quad + 2m(n-1)(n-2)H(s)^2H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)\\
&\quad + m(n-1)(n-2)H(s)^2H(t)H(u) + 2m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)^2H(t)H(u)\\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u) + 2m(n-1)(n-2)H(s)^2H(t)H(u)\\
&\quad + m(n-1)(n-2)H(s)H(t)H(u) + m(n-1)(n-2)H(s)^2H(t)H(u)\\
&\quad + 2m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(s)H(t)^2H(u)\\
&\quad + 2m(n-1)(n-2)H(s)H(t)^2H(u) + 4m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + 4m(n-1)(n-2)H(s)H(u)^2 + 4m(n-1)(n-2)H(s)^2H(u)^2\\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + m(n-1)(n-2)H(s)^2H(t)H(u) + m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + m(n-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)^2H(u)\\
&\quad + m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(s)^2H(u)^2\\
&\quad + 4m(n-1)(n-2)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)H(s)H(t)H(u)^2\\
&\quad + 2m(n-1)(n-2)(n-3)H(s)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&\quad + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)\\
&\quad + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u) + m(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u)\\
&\quad + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&\quad + 4m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&\quad + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u) + m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&\quad + m(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + 2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&\quad + 2m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)
\end{aligned}
$$

$$
\begin{aligned}
&+ 2m(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + 4m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)H(s)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 \\
&+ 4m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 \\
&+ 4m(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&+ 4m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2 \\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u) \\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ 4m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2 \\
&+ 2m(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 \\
&+ m(n-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

Thus the integral of equation (27) is equivalent to

$$
\begin{aligned}
\frac{-2}{n^5 m} \int_{-\infty}^{\infty} \int_{-\infty}^{s} \int_{-\infty}^{t} & mnH(s)H(u) + mn(n-1)H(s)^2H(u) + 8mn(n-1)H(s)H(u)^2 \\
&+ 6mn(n-1)H(s)H(t)H(u) + 15mn(n-1)(n-2)H(s)H(t)H(u)^2 \\
&+ 3mn(n-1)(n-2)H(s)H(t)^2H(u) + 3mn(n-1)(n-2)H(s)^2H(t)H(u) \\
&+ 4mn(n-1)(n-2)H(t)^2H(u)^2 + 5mn(n-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 \\
&+ mn(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + 4mn(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&+ mn(n-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

Equation (28) is equivalent to

$$
\begin{aligned}
&\frac{4}{n^4m^2}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{n}\sum_{p=1}^{m}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}}\right]\\
&=\frac{4}{n^4m^2}\Bigg\{m\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}{1_{\{x_j\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^21_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_k \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_k \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_k \geq s\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_k \geq t\}}{}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_k \geq t\}}{}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}{}^2 1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_k\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+m(m-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_k \geq s\}}1_{\{x_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_j \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_l \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_l \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}{}^2 1_{\{x_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_l \geq u\}}1_{\{y_o \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_l \geq t\}}1_{\{x_o \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_o \geq u\}}1_{\{y_p \geq u\}}\right] \Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{4}{n^4m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(u)^2 + m(m-1)H(s)H(u)^2 + m(m-1)H(s)H(u)^2 \\
&\quad + m(n-1)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 + m(m-1)H(s)^2H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 + m(n-1)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(m-1)H(s)^2H(u)^2 + m(n-1)H(t)H(u)^2 \\
&\quad + 2m(m-1)H(s)H(t)H(u)^2 + 2m(n-1)H(t)H(u)^2 + 2m(m-1)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 + m(m-1)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 + m(n-1)H(s)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + 2m(m-1)H(s)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)^2H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)^2H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)^2H(t)H(u)^2 + m(n-1)(n-2)H(t)H(u)^2
\end{aligned}
$$

$$
\begin{aligned}
&+ m(m-1)(n-2)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(n-1)(n-2)H(t)H(u)^2\\
&+ 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2\\
&+ 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(n-1)(n-2)(n-3)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ 2m(n-1)(n-2)(n-3)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Thus the integral of equation (28) is equivalent to

$$\begin{aligned}
&\frac{4}{n^4m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(u)^2 + mn(n+m-2)H(s)H(u)^2 + 6mn(n-1)H(t)H(u)^2 \\
&\quad + mn(m-1)(n-1)H(s)^2H(u)^2 + 3mn(n-1)(2m+n-4)H(s)H(t)H(u)^2 \\
&\quad + 3mn(n-1)(n-2)H(t)^2H(u)^2 + 3mn(m-1)(n-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + mn(n-1)(n-2)(3m+n-6)H(s)H(t)^2H(u)^2 \\
&\quad + mn(m-1)(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}$$

Equation (29) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^3m^3}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{n}\sum_{o=1}^{m}\sum_{p=1}^{m}\mathrm{E}\left[1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq s\}}1_{\{x_l\geq s\}}1_{\{y_o\geq u\}}1_{\{y_p\geq u\}}\right]\\
&=\frac{1}{n^6}\Bigg\{m\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}{}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}{}^2 1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+4m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}{}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}{}^2\right]\\
&\quad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&\quad+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\quad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&\quad+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]
\end{aligned}
$$

$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^2 {1_{\{y_k\geq u\}}}^2\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 {1_{\{y_k\geq u\}}}^2\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}{1_{\{x_k\geq t\}}}^2 {1_{\{y_i\geq u\}}}^2\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}{1_{\{x_k\geq t\}}}^2 {1_{\{y_i\geq u\}}}^2\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{y_k\geq u\}}}^2\right]$$
$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}{1_{\{x_k\geq t\}}}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+4m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_k\geq s\}}{1_{\{x_i\geq t\}}}^2 {1_{\{y_j\geq u\}}}^2\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}{1_{\{x_i\geq t\}}}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}{1_{\{y_i\geq u\}}}^2\right]$$

$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}{}^2\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]$$

$$
\begin{aligned}
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+ 4m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{y_l\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{y_o\geq s\}}1_{\{x_i\geq t\}}{}^2 1_{\{y_j\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{y_o\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_i\geq u\}}{}^2\right]\\
&+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+ 4m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{y_o\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{y_k\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_l\geq u\}}1_{\{y_o\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_l\geq t\}}1_{\{x_o\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_l\geq t\}}1_{\{x_o\geq t\}}1_{\{y_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_o\geq s\}}1_{\{y_p\geq s\}}1_{\{x_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_k\geq u\}}1_{\{y_l\geq u\}}\right]\Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(t)H(u) + 2m(m-1)H(t)H(u)^2 + m(m-1)H(s)H(t)H(u) \\
&\quad + m(n-1)H(s)H(t)H(u) + 2m(n-1)H(t)^2H(u) + m(m-1)H(s)H(t)H(u) \\
&\quad + m(m-1)H(s)^2H(t)H(u) + m(n-1)H(s)H(t)H(u) + 2m(m-1)H(t)H(u)^2 \\
&\quad + 2m(m-1)H(s)H(t)H(u)^2 + 4m(m-1)H(t)^2H(u)^2 + 2m(m-1)H(s)H(t)^2H(u) \\
&\quad + 2m(n-1)H(t)^2H(u) + 4m(m-1)H(t)^2H(u)^2 + m(n-1)H(t)H(u) \\
&\quad + m(m-1)H(s)^2H(t)H(u) + 2m(m-1)H(s)H(t)^2H(u) + 2m(m-1)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u) \\
&\quad + m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(m-1)(m-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u) + 2m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u) + m(m-1)(n-2)H(s)^2H(t)H(u) \\
&\quad + 2m(m-1)(n-2)H(t)H(u)^2 + 2m(m-1)(m-2)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(m-2)H(s)^2H(t)H(u)^2 + 2m(m-1)(m-2)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 4m(m-1)(m-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u) + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 4m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)^2H(u) \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u) + 2m(m-1)(n-2)H(s)^2H(t)^2H(u) \\
&\quad + m(m-1)(n-2)H(s)^2H(t)H(u) + m(n-1)(n-2)H(s)H(t)H(u) \\
&\quad + 2m(m-1)(n-2)H(s)^2H(t)^2H(u) + 2m(n-1)(n-2)H(t)^2H(u) \\
&\quad + 4m(m-1)(m-2)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + 4m(m-1)(m-2)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 4m(m-1)(n-2)H(t)^2H(u)^2 + 4m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)^2H(t)H(u) + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 4m(m-1)(n-2)H(t)^2H(u)^2 + 4m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)(n-3)H(s)H(t)H(u)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u) \\
&\quad + m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u) \\
&\quad + 4m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2 + 4m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)H(u) \\
&\quad + m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u) + 2m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 \\
&\quad + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u) + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)
\end{aligned}
$$

$$
\begin{aligned}
&+2m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2+2m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2+4m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2\\
&+4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+4m(m-1)(n-2)(n-3)H(t)^2H(u)^2\\
&+4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+4m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+4m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)\\
&+2m(m-1)(m-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+2m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+4m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+2m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+m(m-1)(m-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Thus the integral of equation (29) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u)+2mn(m-1)H(t)H(u)^2+2mn(n-1)H(t)^2H(u)\\
&\quad+mn(m+n-2)H(s)H(t)H(u)+mn(m-1)(n-1)H(s)^2H(t)H(u)\\
&\quad+mn(m-1)(2n+m-4)H(s)H(t)H(u)^2+mn(n-1)(2m+n-4)H(s)H(t)^2H(u)\\
&\quad+4mn(m-1)(n-1)H(t)^2H(u)^2+mn(m-1)(m-2)(n-1)H(s)^2H(t)H(u)^2\\
&\quad+mn(m-1)(n-1)(n-2)H(s)^2H(t)^2H(u)\\
&\quad+2mn(m-1)(n-1)(m+n-4)H(s)H(t)^2H(u)^2\\
&\quad+mn(m-1)(m-2)(n-1)(n-2)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Equation (30) is equivalent to

$$
\begin{aligned}
&\frac{4}{n^4m^2}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{n}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{x_p\geq u\}}\right]\\
&=\frac{4}{n^4m^2}\Bigg\{m\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}{1_{\{x_j\geq u\}}}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+2m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+2m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\quad+m(n-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]\\
&\quad+m(m-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}{1_{\{x_i\geq u\}}}^2\right]
\end{aligned}
$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]$$

$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]$$

$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]$$

$$+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]$$

$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]$$

$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]$$

$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]$$

$$+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}{}^2\right]$$

$$+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_k\geq u\}}{}^2\right]$$

$$+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]$$

$$
\begin{aligned}
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_k \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_k \geq u\}}{}^2\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_j \geq s\}}1_{\{x_k \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{y_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}{}^2\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{y_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ 2m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_k\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{x_l\geq u\}}\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}{}^2\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{x_k\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{x_j\geq u\}}\right]
\end{aligned}
$$

$$+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_k \geq u\}}1_{\{x_l \geq u\}}\right]$$

$$+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_k \geq u\}}1_{\{x_l \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_j \geq t\}}1_{\{y_l \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_j \geq t\}}1_{\{y_l \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{y_j \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_j \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_j \geq t\}}1_{\{y_l \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_j \geq t\}}1_{\{y_l \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_j \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_j \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_l \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_l \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j \geq s\}}1_{\{x_l \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_l \geq t\}}1_{\{y_o \geq t\}}{1_{\{x_i \geq u\}}}^2\right]$$

$$+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_l \geq t\}}1_{\{y_o \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_j \geq u\}}1_{\{x_k \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_l \geq t\}}1_{\{y_o \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_l \geq t\}}1_{\{y_o \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ 2m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]$$

$$+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right]$$

$$+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right]$$

$$+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right]$$

$$+ m(n-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_l \geq u\}}1_{\{x_o \geq u\}}\right]$$

$$+ m(m-1)(n-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_o \geq t\}}1_{\{y_p \geq t\}}1_{\{x_i \geq u\}}1_{\{x_j \geq u\}}\right]\Bigg\}.$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{4}{n^4m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(t)H(u) + m(m-1)H(s)H(t)H(u) + m(n-1)H(u)H(t)^2 \\
&\quad + m(m-1)H(s)H(t)H(u) + m(n-1)H(s)H(t)H(u) + 2m(n-1)H(u)^2H(t) \\
&\quad + m(m-1)H(s)H(t)^2H(u) + m(m-1)H(s)^2H(t)H(u) + m(n-1)H(u)H(t)^2 \\
&\quad + m(n-1)H(t)H(u) + m(m-1)H(s)^2H(t)H(u) + m(m-1)H(s)H(t)^2H(u) \\
&\quad + m(n-1)H(u)H(t)^2 + 2m(m-1)H(s)H(t)H(u)^2 + 2m(n-1)H(u)^2H(t) \\
&\quad + 2m(m-1)H(s)H(t)H(u)^2 + 2m(n-1)H(u)^2H(t) + m(n-1)H(u)^2H(t) \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + mm-1)H(s)H(t)H(u)^2 + m(n-1)H(u)^2H(t) \\
&\quad + m(n-1)H(u)H(t)^2 + m(m-1)H(s)H(t)^2H(u) + 2m(m-1)H(s)H(t)H(u)^2 \\
&\quad + m(n-1)H(s)H(t)H(u) + m(m-1)H(s)H(t)^2H(u) + m(m-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + m(m-1)(n-2)H(s)^2H(t)H(u) + m(n-1)(n-2)H(u)^2H(t)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u) + m(m-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + m(m-1)(n-2)H(s)^2H(t)H(u) + m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(u)^2H(t)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)^2H(u) + m(m-1)(n-2)H(u)H(t)^2H(s)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)^2H(u) + m(m-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + m(n-1)(n-2)H(u)H(t)^2 + m(m-1)(n-2)H(u)H(t)^2H(s)^2 \\
&\quad + m(m-1)(n-2)H(s)^2H(t)H(u) + m(m-1)(n-2)H(u)H(t)^2H(s)^2 \\
&\quad + m(m-1)(n-2)H(s)^2H(t)H(u) + m(n-1)(n-2)H(s)H(t)H(u) \\
&\quad + m(m-1)(n-2)H(s)H(t)^2H(u) + m(m-1)(n-2)H(u)H(t)^2H(s)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + m(n-1)(n-2)H(s)H(t)^2H(u) + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)^2H(u) + m(n-1)(n-2)H(s)H(t)^2H(u) \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(u)^2H(t)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(u)^2H(t)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)H(u)^2 + 2m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + 2m(n-1)(n-2)H(u)^2H(t) + 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(u)^2H(t)^2 \\
&\quad + m(m-1)(n-2)H(u)H(t)^2H(s)^2 + m(n-1)(n-2)H(u)H(t)^2
\end{aligned}
$$

$$
\begin{aligned}
&+ m(m-1)(n-2)H(u)H(t)^2H(s)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)H(u)^2H(t)\\
&+ 2m(m-1)(n-2)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)\\
&+ m(m-1)(n-2)(n-3)H(u)H(t)^2H(s)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)\\
&+ m(m-1)(n-2)(n-3)H(u)H(t)^2H(s)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ 2m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(u)H(t)^2H(s)^2\\
&+ m(m-1)(n-2)(n-3)H(u)H(t)^2H(s)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u) + m(m-1)(n-2)(n-3)H(u)H(t)^2H(s)^2\\
&+ m(m-1)(n-2)(n-3)H(u)H(t)^2H(s)^2 + m(n-1)(n-2)(n-3)H(s)H(t)^2H(u)\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(n-1)(n-2)(n-3)H(u)^2H(t)^2\\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + 2m(n-1)(n-2)(n-3)H(u)^2H(t)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ 2m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + 2m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(u)H(t)^2H(s)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2\\
&+ 2m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2\\
&+ m(n-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}
$$

Thus the integral of equation (30) is equivalent to

$$
\begin{aligned}
&\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u) + mn(m+n-2)H(s)H(t)H(u) + 2mn(n-1)H(t)^2H(u) \\
&\quad + 4mn(n-1)H(t)H(u)^2 + mn(n-1)(2m+n-4)H(s)H(t)^2H(u) \\
&\quad + mn(m-1)(n-1)H(s)^2H(t)H(u) + 2mn(n-1)(2m+n-4)H(s)H(t)H(u)^2 \\
&\quad + 3mn(n-1)(n-2)H(t)^2H(u)^2 + mn(m-1)(n-1)(n-2)H(s)^2H(t)^2H(u) \\
&\quad + mn(n-1)(n-2)(3m+n-6)H(s)H(t)^2H(u)^2 + 2mn(m-1)(n-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + mn(m-1)(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

Equation (31) is equivalent to

$$
\begin{aligned}
&\frac{-8}{n^3m^3}\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{n}\sum_{l=1}^{m}\sum_{o=1}^{n}\sum_{p=1}^{m}\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_o\geq u\}}1_{\{y_p\geq u\}}\right]\\
&\quad=\frac{-8}{n^3m^3}\Big\{m\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]\\
&\qquad+m(n-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]\\
&\qquad+m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]
\end{aligned}
$$

$$+\, m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\, m(n-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\, m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\, m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\, m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\, m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_k\geq t\}}1_{\{y_k\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$

$$
\begin{aligned}
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{x_j \geq t\}}\mathbb{1}_{\{y_k \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{y_j \geq t\}}\mathbb{1}_{\{x_k \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{x_j \geq t\}}\mathbb{1}_{\{y_k \geq t\}}\mathbb{1}_{\{y_i \geq u\}}\mathbb{1}_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{y_j \geq t\}}\mathbb{1}_{\{x_k \geq t\}}\mathbb{1}_{\{y_i \geq u\}}\mathbb{1}_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_k \geq u\}}\mathbb{1}_{\{y_k \geq t\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_k \geq u\}}\mathbb{1}_{\{y_k \geq t\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_j \geq u\}}\mathbb{1}_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_j \geq u\}}\mathbb{1}_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{y_j \geq u\}}\mathbb{1}_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{y_j \geq u\}}\mathbb{1}_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_k \geq s\}}\mathbb{1}_{\{y_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_k \geq s\}}\mathbb{1}_{\{y_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{y_i \geq u\}}\mathbb{1}_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{y_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{y_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{y_i \geq u\}}\mathbb{1}_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{y_i \geq u\}}\mathbb{1}_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_k \geq t\}}\mathbb{1}_{\{y_k \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{x_k \geq t\}}\mathbb{1}_{\{y_k \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_j \geq t\}}\mathbb{1}_{\{y_k \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{x_j \geq t\}}\mathbb{1}_{\{y_k \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{y_j \geq t\}}\mathbb{1}_{\{x_k \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_i \geq s\}}\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{y_j \geq t\}}\mathbb{1}_{\{x_k \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_k \geq s\}}\mathbb{1}_{\{y_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_j \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_k \geq s\}}\mathbb{1}_{\{y_k \geq s\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_j \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{y_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_j \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_k \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_j \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_j \geq s\}}\mathbb{1}_{\{y_k \geq s\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_j \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_k \geq s\}}\mathbb{1}_{\{y_i \geq t\}}\mathbb{1}_{\{x_j \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[\mathbb{1}_{\{x_i \geq s\}}\mathbb{1}_{\{y_j \geq s\}}\mathbb{1}_{\{x_i \geq t\}}\mathbb{1}_{\{y_j \geq t\}}\mathbb{1}_{\{x_i \geq u\}}\mathbb{1}_{\{y_k \geq u\}}\right]
\end{aligned}
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\begin{aligned}
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(n-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_k \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{y_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{x_j \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right]
\end{aligned}
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\begin{aligned}
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_j \geq s\}}1_{\{y_k \geq s\}}1_{\{y_j \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_j \geq u\}}1_{\{y_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(m-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_j \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_k \geq t\}}1_{\{y_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_i \geq s\}}1_{\{x_k \geq t\}}1_{\{y_l \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_k \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{x_i \geq u\}}1_{\{y_j \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}1_{\{y_i \geq t\}}1_{\{y_i \geq u\}}1_{\{x_j \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_k \geq t\}}1_{\{x_l \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k \geq s\}}1_{\{y_l \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{x_i \geq u\}}1_{\{y_i \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{x_i \geq u\}}1_{\{y_l \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{x_i \geq t\}}1_{\{y_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_l \geq u\}}\right] \\
&+ m(n-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i \geq s\}}1_{\{x_j \geq s\}}1_{\{y_i \geq t\}}1_{\{x_k \geq t\}}1_{\{y_i \geq u\}}1_{\{x_l \geq u\}}\right]
\end{aligned}
$$

$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{y_j\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_j\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_k\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_k\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_k\geq s\}}1_{\{y_l\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$

$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_j\geq u\}}1_{\{y_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{y_j\geq u\}}1_{\{x_l\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{x_i\geq u\}}1_{\{y_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{x_j\geq t\}}1_{\{y_l\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_k\geq s\}}1_{\{y_j\geq t\}}1_{\{x_l\geq t\}}1_{\{y_i\geq u\}}1_{\{x_j\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_i\geq s\}}1_{\{x_j\geq t\}}1_{\{y_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_i\geq t\}}1_{\{y_i\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_j\geq s\}}1_{\{y_k\geq s\}}1_{\{x_l\geq t\}}1_{\{y_o\geq t\}}1_{\{x_i\geq u\}}1_{\{y_i\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_i\geq t\}}1_{\{y_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{y_i\geq t\}}1_{\{x_k\geq t\}}1_{\{x_l\geq u\}}1_{\{y_o\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_l\geq t\}}1_{\{y_o\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_l\geq t\}}1_{\{y_o\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_i\geq s\}}1_{\{y_j\geq s\}}1_{\{x_l\geq t\}}1_{\{y_o\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\, m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{y_i\geq s\}}1_{\{x_j\geq s\}}1_{\{x_l\geq t\}}1_{\{y_o\geq t\}}1_{\{y_i\geq u\}}1_{\{x_k\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{y_o\geq s\}}1_{\{x_i\geq t\}}1_{\{y_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$
$$+\, m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l\geq s\}}1_{\{y_o\geq s\}}1_{\{y_i\geq t\}}1_{\{x_j\geq t\}}1_{\{x_i\geq u\}}1_{\{y_k\geq u\}}\right]$$

$$
\begin{aligned}
&+ m(m-1)(m-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{x_i \geq t\}}1_{\{y_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(n-2)(n-3)(n-4)\mathrm{E}\left[1_{\{x_l \geq s\}}1_{\{y_o \geq s\}}1_{\{y_i \geq t\}}1_{\{x_j \geq t\}}1_{\{y_i \geq u\}}1_{\{x_k \geq u\}}\right] \\
&+ m(m-1)(m-2)(n-3)(n-4)(n-5)\mathrm{E}\left[1_{\{x_i \geq s\}}1_{\{y_j \geq s\}}1_{\{x_k \geq t\}}1_{\{y_l \geq t\}}1_{\{x_o \geq u\}}1_{\{y_p \geq u\}}\right] \Bigg\}.
\end{aligned}
$$

Each expectation can be calculated and by taking the integral over the first scenario we get

$$
\begin{aligned}
&\frac{-8}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mH(u)^2 + m(m-1)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 \\
&\quad + m(n-1)H(t)H(u)^2 + m(m-1)H(s)H(u)^2 + m(n-1)H(s)H(u)^2 \\
&\quad + m(m-1)H(t)^2H(u)^2 + m(m-1)H(t)^2H(u)^2 + m(m-1)H(s)^2H(u)^2 \\
&\quad + m(m-1)H(s)H(u)^2 + m(m-1)H(t)^2H(u)^2 + m(m-1)H(t)^2H(u)^2 \\
&\quad + m(n-1)H(s)H(u)^2 + m(m-1)H(t)H(u)^2 + m(m-1)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 + m(m-1)H(t)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(m-1)H(s)H(t)H(u)^2 + m(n-1)H(t)H(u)^2 \\
&\quad + m(n-1)H(u)^2 + m(m-1)H(t)^2H(u)^2 + m(m-1)H(t)^2H(u)^2 \\
&\quad + m(m-1)H(s)^2H(u)^2 + m(m-1)H(s)H(t)H(u)^2 + m(m-1)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)H(t)^2H(u)^2 + m(m-1)H(s)H(t)H(u)^2 + m(m-1)H(t)H(u)^2 \\
&\quad + m(m-1)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(n-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2 \\
&\quad + m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2 \\
&\quad + m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + m(m-1)(m-2)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2
\end{aligned}
$$

$$
\begin{aligned}
&+ m(m-1)(m-2)H(s)^2H(t)H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2\\
&+ m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(n-2)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)H(t)H(u)^2 + m(m-1)(m-2)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)H(s)^2H(t)H(u)^2 + m(n-1)(n-2)H(t)H(u)^2\\
&+ m(m-1)(n-2)H(t)H(u)^2 + m(m-1)(m-2)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)H(s)^2H(t)H(u)^2 + m(n-1)(n-2)H(t)H(u)^2\\
&+ m(m-1)(n-2)H(s)H(u)^2 + m(m-1)(n-2)H(s)^2H(u)^2\\
&+ m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(m-2)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)H(s)^2H(u)^2 + m(n-1)(n-2)H(s)H(u)^2\\
&+ m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 + m(m-1)(n-2)H(s)^2H(u)^2\\
&+ m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2\\
&+ m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2\\
&+ m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2\\
&+ m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(m-2)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(n-2)H(t)^2H(u)^2 + m(m-1)(n-2)H(t)^2H(u)^2\\
&+ m(m-1)(m-2)H(s)^2H(t)^2H(u)^2 + m(m-1)(n-2)H(s)H(t)H(u)^2\\
&+ m(m-1)(n-2)H(s)H(t)H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)H(u)^2\\
&+ m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2\\
&+ m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 + m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2\\
&+ m(n-1)(n-2)(n-3)H(s)H(t)H(u)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2\\
&+ m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2 + m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2
\end{aligned}
$$

$$+\,m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)H(t)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)H(t)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)H(s)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+m(m-1)(n-2)(n-3)H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)H(t)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2+m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2+m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)H(t)^2H(u)^2+m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2+m(m-1)(n-2)(n-3)H(s)^2H(t)H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)^2H(t)H(u)^2+m(m-1)(n-2)(n-3)H(s)H(t)H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)H(s)^2H(t)^2H(u)^2+m(m-1)(n-2)(n-3)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)(n-4)H(s)H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)H(s)^2H(t)^2H(u)^2$$
$$+\,m(m-1)(n-2)(n-3)(n-4)H(s)^2H(t)H(u)^2$$
$$+\,m(m-1)(m-2)(n-3)(n-4)(n-5)H(s)^2H(t)^2H(u)^2du\ dt\ ds$$

Thus the integral of equation (31) is equivalent to

$$\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(u)^2+2mn(n+m-2)H(t)H(u)^2+mn(n+m-2)H(s)H(u)^2$$
$$+4mn(m-1)(n-1)H(t)^2H(u)^2+mn(m-1)(n-1)H(s)^2H(u)^2$$
$$+mn(m^2+4mn+n^2-7m-7n+8)H(s)H(t)H(u)^2$$
$$+2mn(m-1)(n-2)(m+n-4)H(s)H(t)^2H(u)^2$$
$$+mn(m-1)(n-1)(m+n-4)H(s)^2H(t)H(u)^2$$
$$+mn(m-1)(m-2)(n-1)(n-2)H(s)^2H(t)^2H(u)^2du\ dt\ ds.$$

The integral of equation (32) is equivalent to the integral of equation (30) but with n and m permuted. Thus the integral of equation (32) is equivalent to

$$\frac{4}{n^2m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u)+mn(m+n-2)H(s)H(t)H(u)+2mn(m-1)H(t)^2H(u)$$
$$+4mn(m-1)H(t)H(u)^2+mn(m-1)(2n+m-4)H(s)H(t)^2H(u)$$
$$+mn(m-1)(n-1)H(s)^2H(t)H(u)+2mn(m-1)(2n+m-4)H(s)H(t)H(u)^2$$
$$+3mn(m-1)(m-2)H(t)^2H(u)^2+mn(m-1)(m-2)(n-1)H(s)^2H(t)^2H(u)$$
$$+mn(m-1)(m-2)(3n+m-6)H(s)H(t)^2H(u)^2$$
$$+2mn(m-1)(m-2)(n-1)H(s)^2H(t)H(u)^2$$
$$+mn(m-1)(m-2)(m-3)(n-1)H(s)^2H(t)^2H(u)^2du\ dt\ ds.$$

The integral of equation (33) is equivalent to the integral of equation (29) but with n and m permuted. Thus the integral of equation (33) is equivalent to

$$\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u)+2mn(m-1)H(t)^2H(u)+2mn(n-1)H(t)H(u)^2$$
$$+mn(m+n-2)H(s)H(t)H(u)+mn(m-1)(n-1)H(s)^2H(t)H(u)$$
$$+mn(m-1)(2n+m-4)H(s)H(t)^2H(u)+mn(n-1)(2m+n-4)H(s)H(t)H(u)^2$$
$$+4mn(m-1)(n-1)H(t)^2H(u)^2+mn(m-1)(m-2)(n-1)H(s)^2H(t)^2H(u)$$
$$+mn(m-1)(n-1)(n-2)H(s)^2H(t)H(u)^2$$
$$+2mn(m-1)(n-1)(n+m-4)H(s)H(t)^2H(u)^2$$
$$+mn(m-1)(m-2)(n-1)(n-2)H(s)^2H(t)^2H(u)^2du\ dt\ ds.$$

The integral of equation (35) is equivalent to the integral of equation (28) but with n and m permuted. Thus the integral of equation (35) is equivalent to

$$\frac{4}{n^2m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(u)^2+mn(m+n-2)H(s)H(u)^2+6mn(m-1)H(t)H(u)^2$$
$$+mn(m-1)(n-1)H(s)^2H(u)^2+3mn(m-1)(2n+m-4)H(s)H(t)H(u)^2$$
$$+3mn(m-1)(m-2)H(t)^2H(u)^2+3mn(m-1)(m-2)(n-1)H(s)^2H(t)H(u)^2$$
$$+mn(m-1)(m-2)(3n+m-6)H(s)H(t)^2H(u)^2$$
$$+mn(m-1)(m-2)(m-3)(n-1)H(s)^2H(t)^2H(u)^2du\ dt\ ds.$$

The integral of equation (36) is equivalent to the integral of equation (27) but with n and m permuted. Thus the integral of equation (36) is equivalent to

$$\begin{aligned}\frac{-2}{nm^5}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & mnH(s)H(u) + mn(m-1)H(s)^2H(u) + 8mn(m-1)H(s)H(u)^2 \\ & + 6mn(m-1)H(s)H(t)H(u) + 15mn(m-1)(m-2)H(s)H(t)H(u)^2 \\ & + 3mn(m-1)(m-2)H(s)H(t)^2H(u) + 3mn(m-1)(m-2)H(s)^2H(t)H(u) \\ & + 4mn(m-1)(m-2)H(s)^2H(u)^2 + 5mn(m-1)(m-2)(m-3)H(s)^2H(t)H(u)^2 \\ & + mn(m-1)(m-2)(m-3)H(s)^2H(t)^2H(u) \\ & + 4mn(m-1)(m-2)(m-3)H(s)H(t)^2H(u)^2 \\ & + mn(m-1)(m-2)(m-3)(m-4)H(s)^2H(t)^2H(u)^2du\ dt\ ds.\end{aligned}$$

The integral of equation (37) is equivalent to the integral of equation (26) but with n and m permuted. Thus the integral of equation (37) is equivalent to

$$\begin{aligned}\frac{1}{n^4m^2}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & mnH(s)H(u) + mn(m-1)H(s)^2H(u) + 4mn(n-1)H(s)H(u)^2 \\ & + 3mn(n-1)H(s)H(t)H(u) + 4mn(m-1)(n-2)H(s)^2H(u)^2 \\ & + 3mn(m-1)(n-1)H(s)^2H(t)H(u) + 5mn(n-1)(n-2)H(s)H(t)H(u)^2 \\ & + mn(n-1)(n-2)H(s)H(t)^2H(u) + 5mn(m-1)(n-1)(n-2)H(s)^2H(t)^2H(u) \\ & + mn(m-1)(n-1)(n-2)H(s)^2H(t)H(u)^2 + mn(n-1)(n-2)(n-3)H(s)H(t)^2H(u)^2 \\ & + mn(m-1)(n-1)(n-2)(n-3)H(s)^2H(t)^2H(u)^2du\ dt\ ds.\end{aligned}$$

The integral of equation (38) is equivalent to the integral of equation (25) but with n and m permuted. Thus the integral of equation (38) is equivalent to

$$\begin{aligned}\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & mnH(u)^2 + 3mn(n-1)H(t)H(u)^2 + 3mnH(s)H(u)^2 \\ & + 9mn(m-1)(n-1)H(s)H(t)H(u)^2 + mn(n-1)(n-2)H(t)^2H(u)^2 \\ & + mn(m-1)(m-2)H(s)^2H(u)^2 + 3mn(m-1)(n-1)(n-2)H(s)H(t)^2H(u)^2 \\ & + 3mn(m-1)(m-2)(n-1)H(s)^2H(t)H(u)^2 \\ & + mn(m-1)(m-2)(n-1)(n-2)H(s)^2H(t)^2H(u)^2du\ dt\ ds.\end{aligned}$$

The integral of equation (39) is equivalent to the integral of equation (24) but with n and m permuted. Thus the integral of equation (39) is equivalent to

$$\begin{aligned}\frac{1}{n^2m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & mnH(t)H(u) + mn(m-1)H(t)^2H(u) + 4mn(m-1)H(t)H(u)^2 \\ & + 3mn(m-1)H(s)H(t)H(u) + 4mn(m-1)(n-2)H(t)^2H(u)^2 \\ & + 3mn(m-1)(n-1)H(s)H(t)^2H(u) + 5mn(m-1)(m-2)H(s)H(t)H(u)^2 \\ & + mn(m-1)(m-2)H(s)^2H(t)H(u) + 5mn(m-1)(m-2)(n-1)H(s)H(t)^2H(u)^2 \\ & + mn(m-1)(m-2)(n-1)H(s)^2H(t)^2H(u) \\ & + mn(m-1)(m-2)(m-3)H(s)^2H(t)H(u)^2 \\ & + mn(m-1)(m-2)(m-3)(n-1)H(s)^2H(t)^2H(u)^2du\ dt\ ds.\end{aligned}$$

The integral of equation (40) is equivalent to the integral of equation (23) but with n and m permuted. Thus the integral of equation (40) is equivalent to

$$\begin{aligned}
&\frac{-2}{n^3m^3}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u) + 2mn(n-1)H(t)H(u)^2 + mn(n-1)H(t)^2H(u) \\
&\quad + 3mn(m-1)H(s)H(t)H(u) + 3mn(m-1)(n-1)H(s)H(t)^2H(u) \\
&\quad + 6mn(m-1)(n-1)H(s)H(t)H(u)^2 + mn(n-1)(n-2)H(t)^2H(u)^2 \\
&\quad + mn(m-1)(m-2)H(s)^2H(t)H(u) + 3mn(m-1)(n-1)(n-2)H(s)H(t)^2H(u)^2 \\
&\quad + 2mn(m-1)(m-2)(n-1)H(s)^2H(t)H(u)^2 \\
&\quad + mn(m-1)(m-2)(n-1)H(s)^2H(t)^2H(u) \\
&\quad + mn(m-1)(m-2)(n-1)(n-2)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}$$

The integral of equation (41) is equivalent to the integral of equation (22) but with n and m permuted. Thus the integral of equation (41) is equivalent to

$$\begin{aligned}
&\frac{4}{n^2m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(u)^2 + mn(n+4m-5)H(t)H(u)^2 + 3mn(m-1)H(s)H(u)^2 \\
&\quad + 4mn(m-1)(n-1)H(t)^2H(u)^2 + mn(m-1)(3n+5m-13)H(s)H(t)H(u)^2 \\
&\quad + mn(m-1)(m-2)H(s)^2H(u)^2 + 5mn(m-1)(m-2)(n-1)H(s)H(t)^2H(u)^2 \\
&\quad + mn(m-1)(m-2)(n+m-4)H(s)^2H(t)H(u)^2 \\
&\quad + mn(m-1)(m-2)(m-3)(n-1)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}$$

The integral of equation (42) is equivalent to the integral of equation (21) but with n and m permuted. Thus the integral of equation (42) is equivalent to

$$\begin{aligned}
&\frac{-2}{nm^5}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u) + 4mn(m-1)H(t)^2H(u) + 8mn(m-1)H(t)H(u)^2 \\
&\quad + 3mn(m-1)H(s)H(t)H(u) + 9mn(m-1)(m-2)H(t)^2H(u)^2 \\
&\quad + mn(m-1)(m-2)H(s)^2H(t)H(u) + 5mn(m-1)(m-2)H(s)H(t)^2H(u) \\
&\quad + 10mn(m-1)(m-2)H(s)H(t)H(u)^2 + 7mn(m-1)(m-2)(m-3)H(s)H(t)^2H(u)^2 \\
&\quad + mn(m-1)(m-2)(m-3)H(s)^2H(t)^2H(u) \\
&\quad + 2mn(m-1)(m-2)(m-3)H(s)^2H(t)H(u)^2 \\
&\quad + mn(m-1)(m-2)(m-3)(m-4)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}$$

The integral of equation (43) is equivalent to the integral of equation (20) but with n and m permuted. Thus the integral of equation (43) is equivalent to

$$\begin{aligned}
&\frac{1}{n^2m^4}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} mnH(t)H(u) + mn(n-1)H(t)H(u)^2 + 4mn(m-1)H(t)^2H(u) \\
&\quad + 3mn(m-1)H(s)H(t)H(u)^{+}4mn(m-1)(n-1)H(t)^2H(u)^2 \\
&\quad + 3mn(m-1)(n-1)H(s)H(t)H(u)^2 + 5mn(m-1)(m-2)H(s)H(t)^2H(u) \\
&\quad + mn(m-1)(m-2)H(s)^2H(t)H(u) + 5mn(m-1)(m-2)(n-1)H(s)H(t)^2H(u)^2 \\
&\quad + mn(m-1)(m-2)(n-1)H(s)^2H(t)H(u)^2 \\
&\quad + mn(m-1)(m-2)(m-3)H(s)^2H(t)^2H(u) \\
&\quad + mn(m-1)(m-2)(m-3)(n-1)H(s)^2H(t)^2H(u)^2du\ dt\ ds.
\end{aligned}$$

The integral of equation (44) is equivalent to the integral of equation (19) but with n and m permuted. Thus the integral of equation (44) is equivalent to

$$
\begin{aligned}
\frac{-2}{nm^5}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & mnH(u)^2 + 12mn(m-1)H(t)H(u)^2 + 3mn(m-1)H(s)H(u)^2 \\
& + mn(m-1)(m-2)H(s)^2H(u)^2 + 9mn(m-1)(m-2)H(t)^2H(u)^2 \\
& + 15mn(m-1)(m-2)H(s)H(t)H(u)^2 + 7mn(m-1)(m-2)(m-3)H(s)H(t)^2H(u)^2 \\
& + 3mn(m-1)(m-2)(m-3)H(s)^2H(t)H(u)^2 \\
& + mn(m-1)(m-2)(m-3)(m-4)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

The integral of equation (45) is equivalent to the integral of equation (18) but with n and m permuted. Thus the integral of equation (45) is equivalent to

$$
\begin{aligned}
\frac{1}{m^6}\int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} & mH(u) + 16m(m-1)H(u)^2 + 12m(m-1)H(t)H(u) \\
& + 3m(m-1)H(s)H(u) + 45m(m-1)(m-2)H(t)H(u)^2 \\
& + 9m(m-1)(m-2)H(t)^2H(u) + m(m-1)(m-2)H(s)^2H(u) \\
& + 20m(m-1)(m-2)H(s)H(u)^2 + 15m(m-1)(m-2)H(s)H(t)H(u) \\
& + 16m(m-1)(m-2)(m-3)H(t)^2H(u)^2 + 35m(m-1)(m-2)(m-3)H(s)H(t)H(u)^2 \\
& + 4m(m-1)(m-2)(m-3)H(s)^2H(u)^2 + 7m(m-1)(m-2)(m-3)H(s)H(t)^2H(u) \\
& + 3m(m-1)(m-2)(m-3)H(s)^2H(t)H(u) \\
& + 9m(m-1)(m-2)(m-3)(m-4)H(s)H(t)^2H(u)^2 \\
& + 5m(m-1)(m-2)(m-3)(m-4)H(s)^2H(t)H(u)^2 \\
& + m(m-1)(m-2)(m-3)(m-4)H(s)^2H(t)^2H(u) \\
& + m(m-1)(m-2)(m-3)(m-4)(m-5)H(s)^2H(t)^2H(u)^2 du\ dt\ ds.
\end{aligned}
$$

If we collect all the integrals of equation (18) to (45) and multiply the result by six then we get

$$
\begin{aligned}
\mathrm{E}[T_{n,m}^3] = \frac{6(n^5+m^5)}{(n+m)^3(nm)^2} \int_{-\infty}^{\infty}\int_{-\infty}^{s}\int_{-\infty}^{t} H(u)\Bigg(&1 + 2\left(\frac{nm(n+m)^2(7m^2-10nm+7n^2)}{n^5+m^5} - 8\right)H(u) \\
&+ 2\left(\frac{nm(n+m)^2(5m^2-7nm+5n^2)}{n^5+m^5} - 6\right)H(t) + \left(\frac{nm(n+m)^2(m^2-nm+n^2)}{n^5+m^5} - 3\right)H(s) \\
&+ 5\left(\frac{nm(n+m)^2(2m^2n+2mn^2-19m^2+25mn-19n^2)}{n^5+m^5} + 18\right)H(t)H(u) \\
&+ \left(\frac{nm(n+m)^2(2m^2n+2mn^2-19m^2+25mn-19n^2)}{n^5+m^5} + 18\right)H(t)^2 \\
&- \left(\frac{nm(n+m)^2(m^2-nm+n^2)}{n^5+m^5} - 2\right)H(s)^2 \\
&+ 2\left(\frac{nm(n+m)^2(m^2n+mn^2-19m^2+26mn-19n^2)}{n^5+m^5} + 20\right)H(s)H(u) \\
&+ \left(\frac{nm(n+m)^2(m^2n+mn^2-27m^2+37mn-27n^2)}{n^5+m^5} + 30\right)H(s)H(t) \\
&- 4\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5} + 24\right)H(t)^2H(u) \\
&- 5\left(\frac{nm(n+m)^2(5m^2n+5mn^2-45m^2+59mn-49n^2)}{n^5+m^5} + 42\right)H(s)H(t)H(u) \\
&- 2\left(\frac{nm(n+m)^2(m^2n+mn^2-12m^2+16mn-12n^2)}{n^5+m^5} + 12\right)H(s)^2H(u) \\
&- \left(\frac{nm(n+m)^2(5m^2n+5mn^2-45m^2+59mn-49n^2)}{n^5+m^5} + 42\right)H(s)H(t)^2 \\
&- \left(\frac{nm(n+m)^2(m^2n+mn^2-17m^2+23mn-17n^2)}{n^5+m^5} + 18\right)H(s)^2H(t) \\
&+ 9\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5} + 24\right)H(s)H(t)^2H(u) \\
&+ 5\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5} + 24\right)H(s)^2H(t)H(u) \\
&+ \left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5} + 24\right)H(s)^2H(t)^2 \\
&- 5\left(\frac{nm(n+m)^2(3m^2n+3mn^2-26m^2+34mn-26n^2)}{n^5+m^5} + 24\right)H(s)^2H(t)^2H(u)\Bigg)ds\,dt\,du.
\end{aligned}
$$

□

2 Additional Figures

In this section, we present some more figures to complement the results in the main text.

2.1 Approximate distribution of $T_{n,m}$ under H_0

In Section 3.2 of the main manuscript, we show that the distribution of the test statistics under the null hypothesis can be well approximated by the generalised Pareto distribution (GDP). To indicates the good approximation, we present in this section the histograms and quantile-quantile plots (QQ-plots) of the test statistics (under H_0), when the data follow the Normal(0,1), Skewed-Normal(2,2,2), Gamma(5,5), and $N(0,1)^{1-\pi} \cdot N(5,2)^{\pi}$ (with $\pi \sim$ Bernoulli(7/8)) distributions. They are presented in Figures S1 to S4. All of the figures indicate that the approximation is very good, especially for the test statistics in the rejection regions.

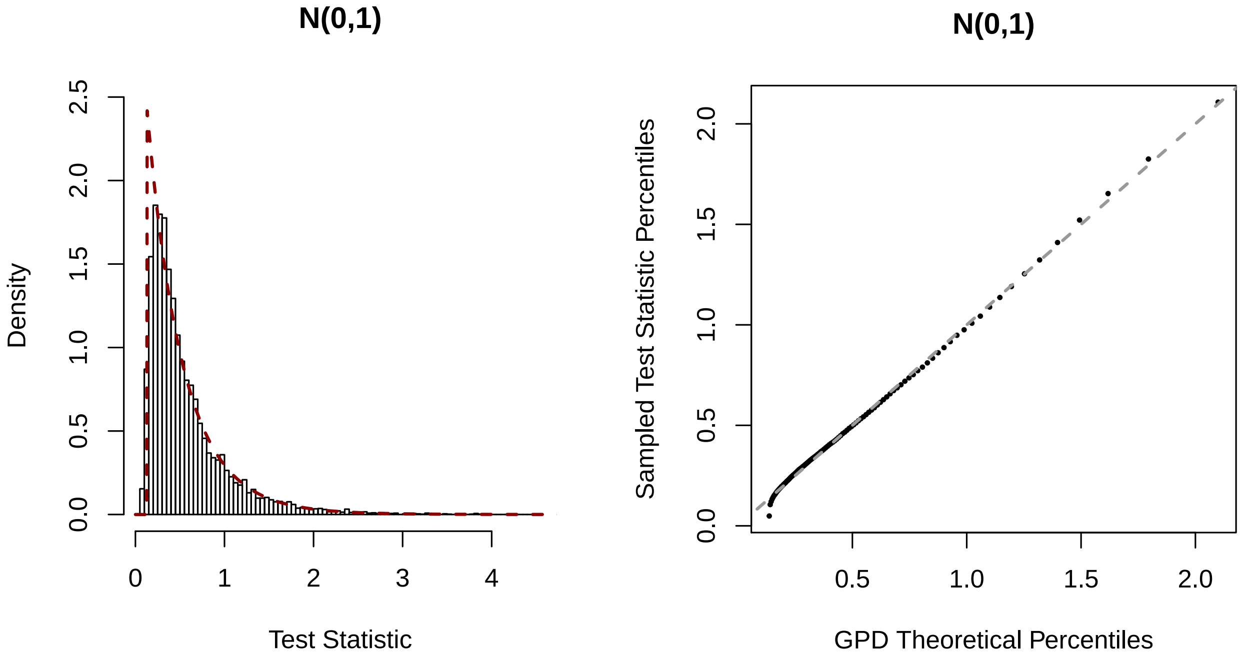


Figure S1: *Histogram (left panel) and quantile-quantile plot (QQ-plot, right panel) of the test statistics $T_{n,m}$ under H_0, when the data are simulated under the Normal(0,1) distribution. The histogram is overlaid with the theoretical generalised Pareto distribution (dashed red line), and the QQ-plot compares the quantiles of the test statistics to the quantiles of the GPD.*

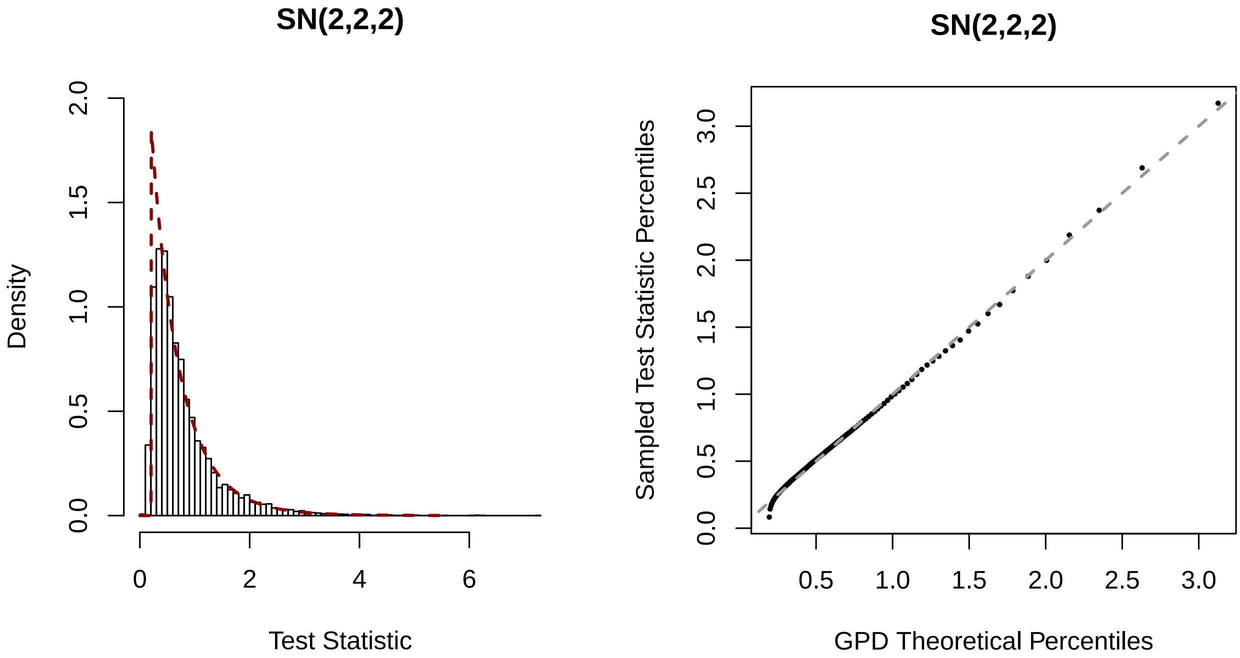


Figure S2: *Histogram (left panel) and quantile-quantile plot (QQ-plot, right panel) of the test statistics* $T_{n,m}$ *under* H_0*, when the data are simulated under the Skewed-Normal(2,2,2) distribution. The histogram is overlaid with the theoretical generalised Pareto distribution (dashed red line), and the QQ-plot compares the quantiles of the test statistics to the quantiles of the GPD.*

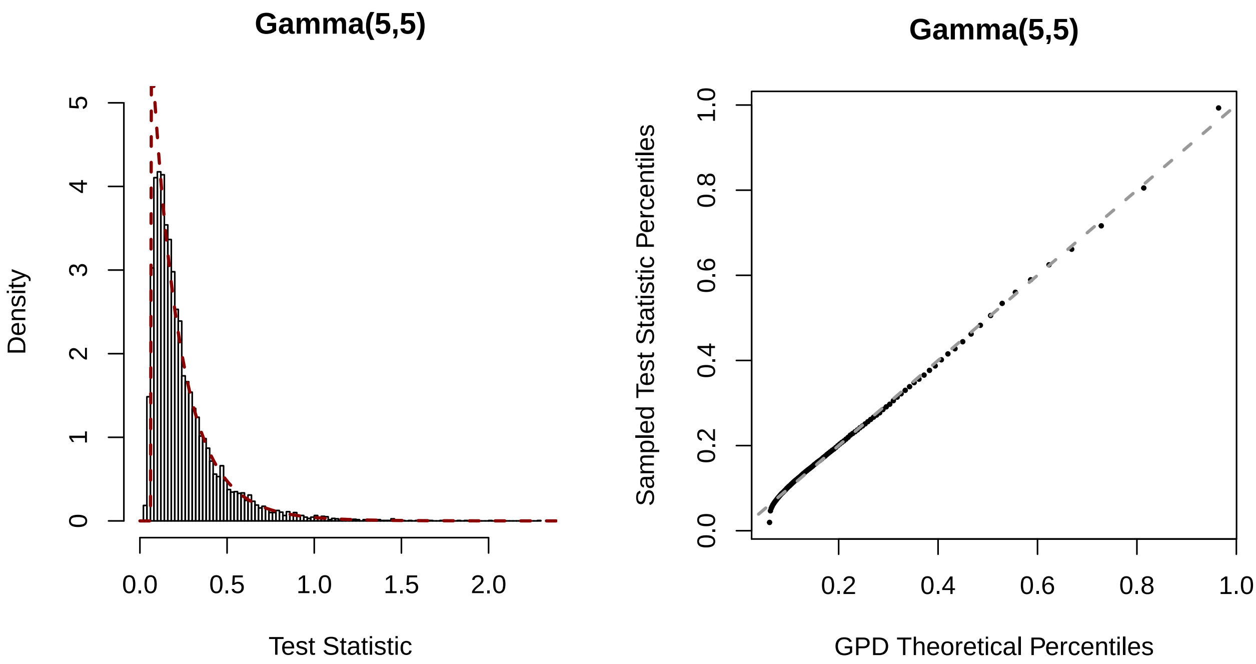


Figure S3: *Histogram (left panel) and quantile-quantile plot (QQ-plot, right panel) of the test statistics* $T_{n,m}$ *under* H_0*, when the data are simulated under the Gamma(5,5) distribution. The histogram is overlaid with the theoretical generalised Pareto distribution (dashed red line), and the QQ-plot compares the quantiles of the test statistics to the quantiles of the GPD.*

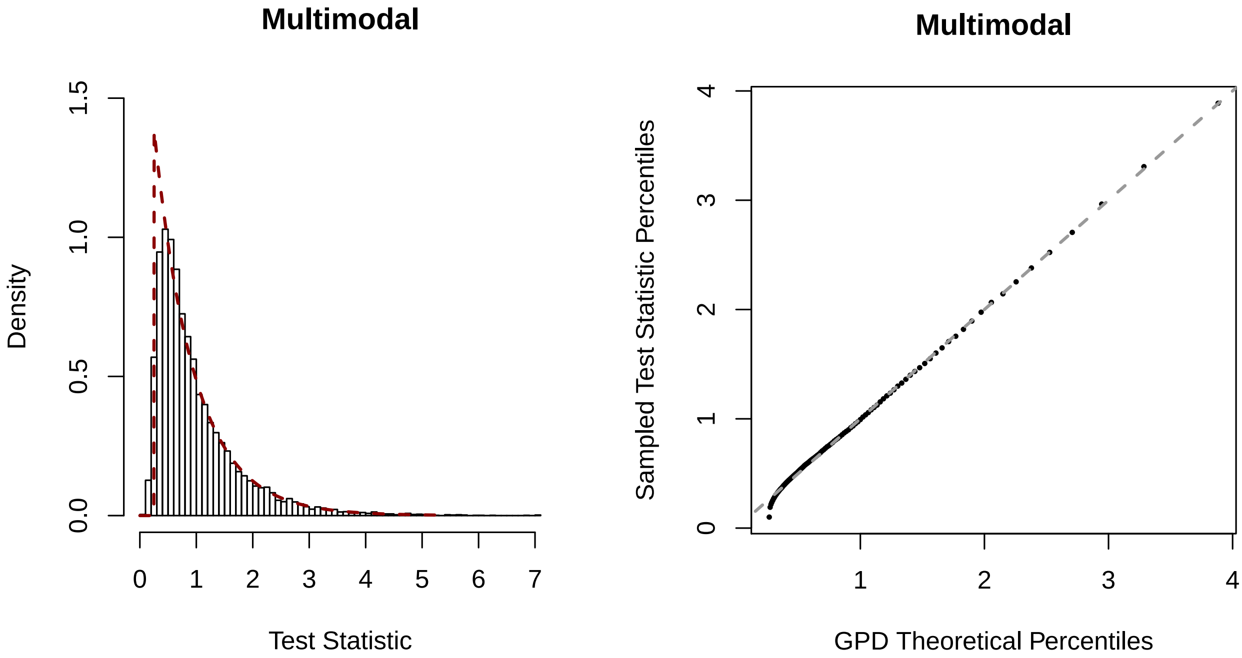
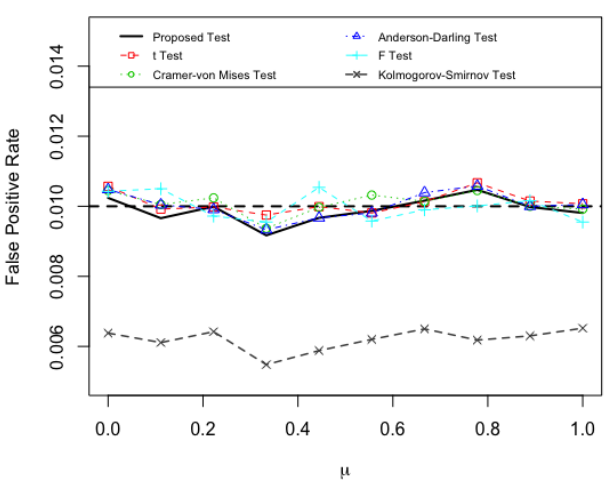


Figure S4: *Histogram (left panel) and quantile-quantile plot (QQ-plot, right panel) of the test statistics* $T_{n,m}$ *under* H_0*, when the data are simulated under the* $N(0,1)^{1-\pi} \cdot N(5,2)^{\pi}$ *(with* $\pi \sim$ *Bernoulli*$(7/8)$*) distribution. The histogram is overlaid with the theoretical generalised Pareto distribution (dashed red line), and the QQ-plot compares the quantiles of the test statistics to the quantiles of the GPD.*

3 Type-I error for 0.01 and 0.001 significance levels

In Section 4.1.1 of the main manuscript, we present the results of type-I error control of the test statistics at the 0.05 significance level, where the generalised Pareto distribution (GPD) is the reference distribution. In this section, we present the type-I error control at the 0.01 and 0.001 significance levels in Figure S5 where we vary the mean. The figure indicates that the type-I error control remains appropriate for the corresponding signficance level. This is not surprising, since the GPD has a good approximation to the test-statistics' null-distribution as seen in Figures S1 to S4.



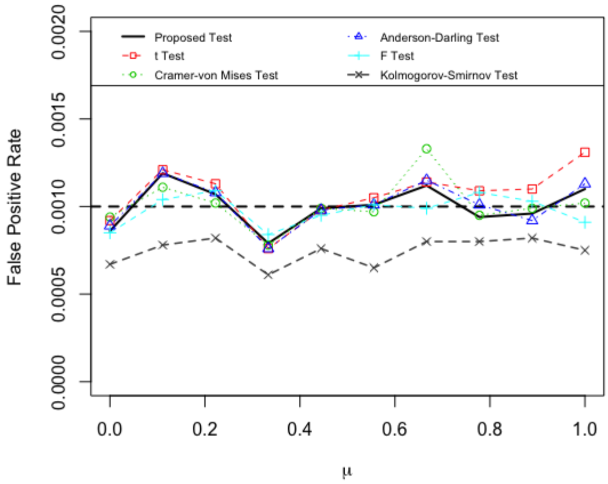


Figure S5: False positive rates for the Cramer test, (two-sample) t-test, Cramer-von Mises test, Anderson Darling test, F-test, and Kolmogorov-Smirnov test at varying μ (from skewed normal $SN(\mu, \sigma^2, \alpha)$) for 0.01 (left panel) and 0.001 (right panel) significance levels.