\[ C(U) = \max I(X, Y_N; U) = 1 - N. \]  \hspace{1cm} (7.5.12)

From (7.5.11) and (7.5.12) together, we get

\[ C(U) = H(Y_N; U) - \sum_{i=1}^{n} q_i \lambda_i^N r_i \frac{\hat{a}_i}{\hat{p}(x_i)}, \]

which is the channel capacity of \( N \) identical cascaded channels.

Hence the proof of **Theorem 7.5.1** completes.

---

### 7.6 Conclusion

The characteristic difference between the problem of communication through channels in cascade and that of communication through a single channel is that, in the latter case, the transmitter possesses the complete knowledge of what it should transmit. In this chapter we have studied the different type of cascaded channels. We have also defined the channel capacity of \( N \) identical cascaded channel and proved two theorems on it.

The general problem of determining the optimal ordering of \( n \) arbitrarily chosen binary channels remains open. However, we have introduced a class of information theoretic problem that deals with channel performance in cascade and estimates the channel capacity with utility.