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# Chapter: 4
# Quadruple Series Equations Containing Jacobi Polynomials

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**Abstract:** Formal solution of Four series equations involving Jacobi Polynomial given in this paper. Finally the solution of four series equations is reduce to Fredholm integral equation of second kind in one independent variable which can be solved by some numerical methods.

## 1. Introduction

Noble (1963) presented formal solution of dual series equations involving Jacobi Polynomials. Later on Lowndes (1968) gave the solution of triple series equations. He reduced the triple series equations to Fredholm, integral equation of second kind which can be solved by some numerical methods. This paper shall be devoted in finding the solution of four series equations involving Jacobi polynomial. Our method is similar to that of Cooke (1963) used in solving triple integral equation of Bessel functions. The analysis given here is purely formal and no attempt is made to justify the various limiting processes

**2. Some useful result:** In the course of the analysis we shall use the following results:

The orthogonality relation Jacobi polynomials is

$$\int_0^1 r^{\lambda}(1-r)^{a-\lambda} J_m(a,\lambda;r) J_n(a,\lambda;r)\,dr = \frac{\delta mn}{\Delta n^2} \qquad a+1>\lambda>0 \quad \ldots\ldots \quad (1)$$

Where $\delta mn$ is the Kronecker delta and,

$$\Delta_{n^2} = \frac{(a+2n)\Gamma(a+n)\Gamma(\lambda+n)}{\Gamma(n+1)(\Gamma(\lambda))\Gamma(1+a-\lambda+n)}$$

It is shown in Noble (1963), when $a+1+\sigma>\sigma>0$,

$$k(r,p) = \left\{\overline{|(\sigma)}\right\}^2 (rp)^{\lambda-1} \sum_{n=0}^{\infty} Jn^2\, pn(\lambda-\sigma,\lambda) J_n(a,\lambda:r) J_n(a,\lambda:p) \quad \ldots\ldots (2)$$

$$= \int_0^t m(s)(r-s)^{\sigma-1}(\rho-s)^{\sigma-1}\,ds \quad \ldots\ldots (3)$$

Where $m(x) = x^{\lambda-\sigma-1}(1-x)^{1-a-\sigma}$ and $t = \min(r,p)$.