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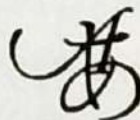
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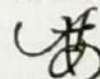
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CONTENTS OF PART - I



Sr. No.	Name & Author Name	Page No.
1	A Study of Management of "Family Business Dynamics" as A Factor in Contributing to the Success or Failure of Family Managed Businessess Dr. Rajesh Mankani	1-13
2	Awareness Evaluation on Hand Hygiene in Apollo Hospitals, Navi Mumbai Ms. Sneha Pramod Vaidya	14-18
3	Ethics and Corporate Social Responsibility Shahida Shakeel Shaikh	19-23
4	Rural Finance and Agriculture: Post Demonetisation Ms. Shubhshree V. Parab	24-27
5	Q - Meixner's Polynomial and Continued Fractions Jayprakash Yadav Manoj Kumar L. Mishra	28-33
6	Recent Trends in Social Sector Expenditures and the Changing Scenario of Community Development in India K. D. Landge	34-38
7	Banking and Finance Ms. Durga Singh	39-44
8	Leadership in Management Dr. Purushottam Wadje	45-51
9	Result of Demonetization CA Kiran Gajjar	52-59
10	Bankers Obligation To Honor Cheque Yogesh Prasad Kolekar	60-63
11	To Study The Role of Technology in Mental Health Services Vandana Solanki	64-70
12	Indian Derivative Market: Issues and Future Prospects Dr. Vinod S. Khapne Mr. Firozkhan Khurshit Khan	71-76
13	Measurement of Wealth Creation Through EVA : Analysis of Select Banking Companies Kailash Chandak	77-89

5

Q - Meixner's Polynomial and Continued Fractions

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Abstract

In this paper an attempt has been made to establish continued fraction for the ratio of two q-meixner's polynomial using some known transformation formula in basic hyper geometric series.

Keywords and phrases: q-meixner's polynomial, basic hyper geometric series, and continued fractions.

1) Notations and known results

The basic hyper geometric series is defined as

$${}_r\phi_s \left[\begin{matrix} (a); z \\ (b) \end{matrix} \right] = \sum_{n=0}^{\infty} \frac{((a); q)_n z^n}{((b); q)_n (q; q)_n}, \quad (1.1)$$

where for the convergence of the series, we have $0 < |q| < 1$ and $|z| < 1$ if $r = s+1$, and for any z if $r \leq s$.

$$((a); q)_n = (a_1; q)_n (a_2; q)_n \dots (a_r; q)_n \text{ and} \quad (1.2)$$

$$((b); q)_n = (b_1; q)_n (b_2; q)_n \dots (b_s; q)_n.$$

The q-shifted factorial is defined as

$$(a; q)_0 = 1 \text{ and } (a; q)_n = (1-a)(1-aq) \dots (1-aq^{n-1}), n=1, 2, 3, \dots \quad (1.3)$$

The q-meixner's polynomial is defined as

$$M_n(x; \beta, \gamma, q) = (\beta; q)_n {}_2\phi_1 \left[\begin{matrix} q^{-n}, x; q, \frac{q^{n+1}}{\gamma} \\ \beta; \end{matrix} \right]. \quad (1.4)$$

[3; p.237 (23)]

We shall also use the following transformation formula in our analysis:

$${}_2\phi_1(q^{-n}, b; c; q, z) = \frac{\left(\frac{c}{b}; q\right)_n}{(c; q)_n} {}_3\phi_2\left(\begin{matrix} q^{-n}, b, bzq^{-n}; q, q \\ 0, bq^{1-n}/c; \end{matrix}\right) \quad (1.5)$$

[2; App.III (III.7)]

2) Main Results

In this paper we have established the following main results

$$(i) \frac{M_n(x; \beta, \gamma, q)}{M_n(xq; \beta, \gamma, q)} = 1 - \frac{A_0 B_0 A_1 B_1}{\delta_x - 1 - \delta_x - 1 - \dots}, \quad (2.1)$$

$$\text{where } A_i = \frac{xq^{1+n+i}(1-q^{-n+i})}{(1-\beta q^{n+i})\gamma}, \quad B_i = \frac{(1-xq^{i+1})\left(1 - \frac{xq^{i+2}}{\gamma\beta}\right)q^{-n+i+1}}{\left(1 - \frac{xq^{-n+i+2}}{\beta}\right)},$$

$$\text{And } \delta_x = \frac{\left(1 - \frac{\beta}{qx}\right)}{\left(1 - \frac{\beta q^{n-1}}{x}\right)}.$$

$$(ii) \frac{(\beta; q)_n {}_2\phi_1\left(q^{-n}, x; q, \frac{q^{n+1}}{\gamma}\right)}{(\beta; q)_n {}_2\phi_1\left(q^{-n+1}, x; q, \frac{q^{n+1}}{\gamma}\right)} = 1 - \frac{C_0 D_0 C_1 D_1}{1 - 1 - 1 - 1 - \dots}, \quad (2.2)$$

where for $i \geq 0$

$$C_i = \frac{(1-xq^i)q^{i+1}}{\gamma(1-\beta q^{n+i})}, \quad D_i = \frac{xq^i(1-xq^{-n+i+1})(1-xq^{2+i})}{(1-xq^{-n+i+2})}. \quad (2.3)$$

Proof of (i): For $i \geq 0$,

$$\text{Let } H_i = (\beta q^i; q)_n {}_2\phi_1\left(\begin{matrix} q^{-n+i}, xq^i; q, \frac{q^{1+n}}{\gamma} \\ \beta q^i; \end{matrix}\right), \quad (2.4)$$

and

$$F_i = (\beta q^i; q)_n {}_2\phi_1\left(\begin{matrix} q^{-n+i}, xq^{i+1}; q, \frac{q^{1+n}}{\gamma} \\ \beta q^i; \end{matrix}\right), \quad (2.5)$$

So,

$$\begin{aligned}
 F_i - H_i &= (\beta q^i; q)_n x q^i \sum_{r=1}^{\infty} \frac{(q^{-n+i}; q)_r (x q^{i+1}; q)_{r-1} \left(\frac{q^{1+n}}{\gamma}\right)^r}{(q; q)_{r-1} (\beta q^i; q)_r} \quad (2.6) \\
 &= (\beta q^i; q)_n x q^i \sum_{r=0}^{\infty} \frac{(q^{-n+i}; q)_{r+1} (x q^{i+1}; q)_r \left(\frac{q^{1+n}}{\gamma}\right)^{r+1}}{(q; q)_r (\beta q^i; q)_{r+1}} \\
 &= \frac{(1 - q^{-n+i}) x q^{n+i+1}}{(1 - \beta q^{n+i}) \gamma} (\beta q^i; q)_n \sum_{r=0}^{\infty} \frac{(q^{-n+i+1}; q)_r (x q^{i+1}; q)_r \left(\frac{q^{1+n}}{\gamma}\right)^r}{(q; q)_r (\beta q^{i+1}; q)_r} \\
 &= \frac{(1 - q^{-n+i}) x q^{n+i+1}}{(1 - \beta q^{n+i}) \gamma} (\beta q^{i+1}; q)_n \sum_{r=0}^{\infty} \frac{(q^{-n+i+1}; q)_r (x q^{i+1}; q)_r \left(\frac{q^{1+n}}{\gamma}\right)^r}{(q; q)_r (\beta q^{i+1}; q)_r} \\
 &= \frac{(1 - q^{-n+i}) x q^{n+i+1}}{(1 - \beta q^{n+i}) \gamma} (\beta q^{i+1}; q)_n {}_2\phi_1 \left(\begin{matrix} q^{-n+i}, x q^{i+1}; q, q^{1+n} / \gamma \\ \beta q^{i+1}; \end{matrix} \right)
 \end{aligned}$$

= $A_i H_{i+1}$, where A_i is given in (i).

So, $F_i - H_i =$. (2.7)

This gives $\frac{H_i}{F_i} = 1 - \frac{A_i}{F_i / H_{i+1}}$. (2.8)

Let us transform and using the transformation formula (1.5), we get:

$$F_i = \left(\frac{\beta}{xq}; q \right)_n {}_3\phi_2 \left(\begin{matrix} q^{-n+i}, xq^{i+1}, xq^{i+2} / \gamma\beta; q, q \\ 0, xq^{-n+i+2} / \beta \end{matrix} \right) \quad (2.9)$$

And

$$H_i = \left(\frac{\beta}{x}; q \right)_n {}_3\phi_2 \left(\begin{matrix} q^{-n+i}, xq^i, xq^{i+1} / \gamma\beta; q, q \\ 0, xq^{-n+i+1} / \beta \end{matrix} \right) \quad (2.10)$$

So,

$$\begin{aligned}
 \frac{\left(\frac{1-\beta}{xq}\right)}{\left(\frac{1-\beta q^{n-1}}{x}\right)} H_{i+1} - F_i &= \left(\frac{\beta}{xq}; q\right)_n q^{-n+i} \sum_{r=0}^{\infty} \frac{(q^{-n+i+1}; q)_r (xq^{i+1}; q)_r \left(\frac{xq^{i+2}}{\gamma\beta}; q\right)_{r+1} q^{r+1}}{(q; q)_r \left(\frac{xq^{-n+i+2}}{\beta q}\right)_{r+1}} \\
 &= \frac{(1 - xq^{i+1}) \left(1 - \frac{xq^{i+2}}{\gamma\beta}\right) q^{-n+i+1}}{\left(1 - \frac{xq^{-n+i+2}}{\beta}\right)} \left(\frac{\beta}{xq}; q\right)_n \sum_{r=0}^{\infty} \frac{(q^{-n+i+1}; q)_r (xq^{i+2}; q)_r \left(\frac{xq^{i+3}}{\gamma\beta}; q\right)_r q^r}{(q; q)_r \left(\frac{xq^{-n+i+3}}{\beta}; q\right)_r}
 \end{aligned}$$

$$= \frac{(1-xq^{i+1}) \left(1 - \frac{xq^{i+2}}{\gamma\beta}\right) q^{-n+i+1}}{\left(1 - \frac{xq^{-n+i+2}}{\beta}\right)} \left(\frac{\beta}{xq}; q\right)_n {}_3\phi_2 \left(\begin{matrix} q^{-n+i+1}, xq^{i+2}, xq^{i+3} / \gamma\beta \\ 0, xq^{-n+i+3} / \beta \end{matrix}; q, q \right),$$

So, we have

$$\frac{\left(1 - \frac{\beta}{xq}\right)}{\left(1 - \frac{\beta q^{n-1}}{x}\right)} H_{i+1} - F_i = B_i F_{i+1}, \quad (2.11)$$

This gives

$$\frac{F_i}{H_{i+1}} = \delta_x - \frac{B_i}{H_{i+1}/F_{i+1}}. \quad (2.12)$$

Where and are given in (I).

Using (2.9) and (2.10) repeatedly and setting, we get (i).

Proof of (ii): For, $i \geq 0$

$$\text{let } H_i = (\beta q^i; q)_n {}_2\phi_1 \left(\begin{matrix} q^{-n+i}, xq^i; q, q^{1+n} / \gamma \\ \beta q^i \end{matrix} \right), \quad (2.13)$$

and

$$F_i = (\beta q^i; q)_n {}_2\phi_1 \left(\begin{matrix} q^{-n+i+1}, xq^{i+1}; q, q^{1+n} / \gamma \\ \beta q^i \end{matrix} \right), \quad (2.14)$$

So,

$$F_i - H_i = \frac{q^{i+1}(1-xq^i)}{\gamma(1-\beta q^{i+n})} (\beta q^{i+1}; q)_n \sum_{r \geq 0} \frac{(q^{-n+i+1}; q)_r (xq^{i+1}; q)_r}{(q; q)_r (\beta q^{i+1}; q)_r} \left(\frac{q^{1+n}}{\gamma}\right)^r, \quad (2.15)$$

$$= C_i H_{i+1}, \text{ Where } C_i \text{ is given in (ii).} \quad (2.16)$$

This gives

$$\frac{H_i}{F_i} = 1 - \frac{C_i}{F_i/H_{i+1}}, \quad (2.17)$$

Where A_i is given in (ii). (2.16)

Let transform using the transformation formula (1.5) we have;

$$F_i = \left(\frac{\beta}{x}; q\right)_n {}_3\phi_2 \left(\begin{matrix} q^{-n+i+1}, xq^i, xq^{i+2} / \beta \\ 0, xq^{-n+i+2} / \beta \end{matrix}; q, q \right) \quad (2.18)$$

and

$$H_i = \left(\frac{\beta}{x}; q\right)_n {}_3\phi_2 \left(\begin{matrix} q^{-n+i}, xq^i, xq^{i+1} / \beta \\ 0, xq^{-n+i+1} / \beta \end{matrix}; q, q \right) \quad (2.19)$$

So,

$$\begin{aligned} H_{i+1} - F_i &= \frac{(1 - q^{-n+i+1}) \left(1 - \frac{xq^{i+2}}{\beta}\right) xq^{i+1}}{\left(1 - \frac{xq^{-n+i+2}}{\beta}\right)} \left(\frac{\beta}{x}; q\right)_n \sum_{r=0}^{\infty} \frac{(q^{-n+i+1}; q)_r (xq^{i+1}; q)_r \left(\frac{xq^{i+3}}{\beta}; q\right)_r}{(q; q)_r \left(\frac{xq^{-n+i+3}}{\beta}; q\right)_r} q^r \\ &= \frac{(1 - q^{-n+i+1}) \left(1 - \frac{xq^{i+2}}{\beta}\right) xq^{i+1}}{\left(1 - \frac{xq^{-n+i+2}}{\beta}\right)} F_{i+1} \end{aligned}$$

This gives

$$\frac{F_i}{H_{i+1}} = 1 - \frac{D_i}{H_{i+1}/F_{i+1}} \quad (2.20)$$

Where D_i is given in (ii).

Now using (2.13) and (2.14) repeatedly and setting we get (ii).

The authors are thankful to **Dr.S.N.Singh, Ex. reader and Head, Department of Mathematics, T.D.P.G College, Jaunpur (U.P.), INDIA**, for his noble guidance during the preparation of this paper.

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