**FRACTIONAL INTEGRAL FORMULAE INVOLVING THE PRODUCT OF A GENERAL CLASS OF POLYNOMIALS AND THE MULTIVARIATE H-FUNCTION**

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**IMA Preprint Series # 1999**

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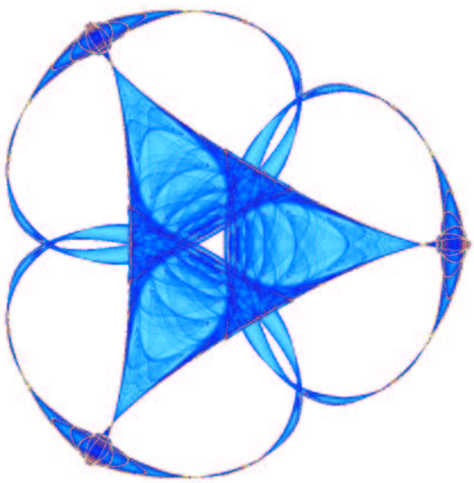

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# FRACTIONAL INTEGRAL FORMULAE INVOLVING THE PRODUCT OF A GENERAL CLASS OF POLYNOMIALS AND THE MULTIVARIATE H-FUNCTION

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## ABSTRACT

In the present paper, we have obtained two fractional integral formulae involving the product of a general class of polynomial and the multivariable H-functions, It has been demonstrated that the special cases of these results are well known results of vast literature.

## 1. INTRODUCTION

With an aim to show some interesting results concerning series summation of the Psi–Function, Ross [6] defined the fractional integral operator as the special case of the Riemann–Liouville fractional integral operator for c=0 and represented it as ${}_cI_z^{v}\{f(z)\}$.

Saigo et al [13] have expressed the fractional calculus operators as general class of polynomials, while Chen et al [1] have associated the fractional calculus operators with a general class of polynomials.

Lin et al [4] has discussed new generating function of generalized Harmite polynomials, Fractional derivatives formulae involving the product of a general class of polynomials and multivariable H–function have been derived by Soni et al [14].

Here we are making an attempt in the direction of obtaining fractional integral formulae involving the product of a general class of polynomials and multivariable H–functions resulting in fractional integral formulae involving the Laguerre and the Hermite polynomials.

## 2.THE FRACTIONAL INTEGRAL FORMULAE

We shall prove the fractional integral formulae

$$ {}_cI_z^v\{z^{\rho}(z+\alpha)^{\sigma}(z+\beta)^{\mu}S_n^m\left[az^u(z+\alpha)^v(z+\beta)^w\right]S_{n'}^{m'}\left[bz^{u'}(z+\alpha)^{v'}(z+\beta)^{w'}\right] $$

$$ \times H\left[x_1z^{u_1}(z+\alpha)^{v_1}(z+\beta)^{w_1},---,x_rz^{u_r}(z+\alpha)^{v_r}(z+\beta)^{w_r}\right]\} $$

$$ =\alpha^{\sigma}\beta^{\mu}z^{\rho}\sum_{s,l,t=0}^{\infty}\sum_{k=0}^{[n/m]}\sum_{k'=0}^{[n'/m']} $$

$$ (-n)_{mk}(-n')_{m'k'}A_{n,k}A_{n',k'}a^kb^k\alpha^{vk+v'k'-l}\beta^{wk+w'k'-t} $$

$$ \times\frac{(-1)^s(z-c)^{s+v}z^{uk+u'k'+l+t-s}}{k!k'!l!t!\Gamma(v)(s+v)s!}\ \mathrm{H}_{P+3,Q+3:*}^{o,N+3:*} $$

$$ \left[\begin{array}{c|c} x_1\alpha^{v_1}\beta^{w_1}z^{u_1} & (-\rho-uk-u'k'-l-t;u_{1,---,}u_r), \\ x_r\alpha^{v_r}\beta^{w_r}z^{u_r} & (s-\rho-uk-u'k'-l-t;u_1,---u_r), \end{array}\right. $$

$$ \begin{array}{l} (-\sigma-vk-v'k';v_1,---v_r),(-\mu-wk-w'k';w_1,--,w_r) \\ (l-\sigma-vk-v'k';v_1,--v_r),(t-\mu-wk-w'k';w_1,--w_r) \end{array} $$

$$ \left.\begin{array}{l} (a_j;\alpha_j',----,\alpha_j^{(r)})_{1.P}:* \\ (b_j;\beta_j',---,\beta_j^{(r)})_{1.Q}:* \end{array}\right] \text{-----------------} (2.1) $$

**Proof-**

For the proof of this result we shall utilize following definition introduced by Srivastava [8] for general class of polynomials

$$ S_n^m[z]=\sum_{k=0}^{[n/m]}\frac{(-n)_{mk}}{k!}A_{n,k}z^k,\ n=0,1,2------(2.2), $$

where m is an arbitrary positive integer and coefficients $A_{n,k}\,(n,k\geq 0)$ are arbitrary constants, real or complex.

and following representation of H – function of r complex variables given by Srivastava and Panda [9],

$$ H[z_1,---,z_r]=H_{P,Q:P',Q';----;P^{(r)},Q^{(r)}}^{o,N:M',N';----;M^{(r)},N^{(r)}} $$

$$\times\left[\begin{matrix} z_1 \\ z_r \end{matrix}\left|\begin{matrix}\left(a_j;\alpha_j^{'},---,\alpha_j^{(r)}\right)_{1.P} : \left(c_j^{'},\gamma_j^{'}\right)_{1.p^{'}};---;\left(c_j^{(r)},\gamma_j^{(r)}\right)_{1.p^{(r)}} \\ \left(b_j;\beta_j^{'},---,\beta_j^{(r)}\right)_{1.Q} : \left(d_j^{'},\delta_j^{'}\right)_{1.Q^{'}};---;\left(d_j^{(r)},\delta_j^{(r)}\right)_{1.Q^{(r)}}\end{matrix}\right.\right]$$

$$=\frac{1}{(2\pi\omega)^r}\int_{L_1}---\int_{L_r}\phi_1(\xi_1)---\phi_r(\xi_r)\psi(\xi_1,---,\xi_r)z_1^{\xi_1}---z_r^{\xi_r}d\xi_1---d\xi_r \text{ -------- (2.3)}$$

where $\omega=\sqrt{-1}$ .

Expressing the general class of polynomials $S_n^m[z]$ *and* $S_{n'}^{m'}[z]$ occurring on its left hand side in the series form given by (2.2) and replacing the multivariable H-function by (2.3), the left hand side of (2.1) (say $\Theta$ ) takes the following form

$$\Theta={}_cI_z^v\{z^\rho(z+\alpha)^\sigma(z+\beta)^\mu\sum_{k=0}^{[n/m]}\frac{(-n)_{mk}}{k!}A_{n,k}$$

$$\left[az^u(z+\alpha)^v(z+\beta)^w\right]^k\sum_{k'=0}^{[n'/m']}\frac{(-n')_{m'k'}}{k'!}A'_{n',k'}\times\left[bz^{u'}(z+\alpha)^{v'}(z+\beta)^{w'}\right]^{k'}$$

$$\frac{1}{(2\pi\omega)^r}\int_{L_1}---\int_{L_r}\psi(\xi_1,--,\xi_r)\phi_1(\xi_1)---\phi_r(\xi_r)\left(x_1z^{u_1}(z+\alpha)^{v_1}(z+\beta)^{w_1}\right)^{\xi_1}$$

$$\left(x_rz^{u_r}(z+\alpha)^{v_r}(z+\beta)^{w_r}\right)^{\xi_r}d\xi_1----d\xi_r\}. \text{ ---------------- (2.4)}$$

Interchanging the order of $\xi_i$ -integrals and fractional integrals involved and then collecting powers of z, $(z+\alpha)$ *and* $(z+\beta)$, we can obtain

$$\Theta=\sum_{k=0}^{[n/m]}\sum_{k'=0}^{[n'/m']}\times\frac{(-n)_{mk}(-n')_{m'k'}A_{n,k}A'_{n',k'}}{k!k'!}$$

$${}_cI_z^v\left\{z^{\rho+uk+u'k'}(z+\alpha)^{\sigma+vk+v'k'}(z+\beta)^{\mu+wk+w'k'}\right.$$

$$\times\frac{1}{(2\pi\omega)^r}\int_{L_1}----\int_{L_r}\psi(\xi_1,---,\xi_r)\phi_1(\xi_1)---\phi_r(\xi_r)\left(x_1z^{u_1}(z+\alpha)^{v_1}(z+\beta)^{w_1}\right)^{\xi_1}$$

$$----\left(x_rz^{u_r}(z+\alpha)^{v_r}(z+\beta)^{w_r}\right)^{\xi_r}d\xi_1----d\xi_r\}$$

Now making use equation of following form of binomial theorem

$$(z+\xi)^\lambda=\xi^\lambda\sum_{m=0}^{\infty}\binom{\lambda}{m}\left(\frac{z}{\xi}\right)^m,\left|\frac{z}{\xi}\right|<1 \quad \text{---------------------------------------- (2.5),}$$

and changing the order of $\xi_i$ –integrals, we have

$$\Theta=\sum_{k=0}^{[n/m]}\sum_{k'=0}^{[n'/m']}\sum_{l,t=0}^{\infty}\times\frac{(-n)_{mk}(-n')_{m'k'}A_{n,k}A'_{n',k'}}{k!k'!l!t!}a^kb^{k'}\alpha^{\sigma+vk+v'k'-l}\beta^{\mu+wk+w'k'-t}$$

$$\times\frac{1}{(2\pi\omega)^r}\int_{L_1}----\int_{L_r}\psi(\xi_1,---,\xi_r)\phi_1(\xi_1)---\phi_r(\xi_r)\left(x_1\alpha^{v_1}\beta^{w_1}\right)^{\xi_1}--\left(x_r\alpha^{v_r}\beta^{w_r}\right)^{\xi_r}$$

$$
{}_{c}I_{z}^{v}\left\{z^{\rho+uk+u'k'+u_1\xi_1+--+u_r\xi_r+l+t}\right\}\frac{\Gamma(\sigma+vk+v'k'+v_1\xi_1+---+v_r\xi_r+1)}{\Gamma(\sigma+vk+v'k'+v_1\xi_1+--+v_r\xi_r-l+1)}
$$

$$
\times\frac{\Gamma(\mu+wk+w'k'+w_1\xi_1+----+w_r\xi_r+1)}{\Gamma(\mu+wk+w'k'+w_1\xi_1+----+w_r\xi_r-t+1)}\,d\xi_1---d\xi_r
$$

Use of fractional integral operator yields

$$
\Theta=\sum_{l,t=0}^{\infty}\sum_{k=0}^{[n/m]}\sum_{k'=0}^{[n'/m']}\frac{(-n)_{mk}(-n')_{m'k'}\;A_{n,k}A'_{n',k'}}{k!\,k'!\,l!\,t!}a^k b^{k'}\alpha^{\sigma+vk+v'k'-l}\beta^{\mu+wk+w'k'-t}
$$

$$
\frac{1}{(2\pi\omega)^r}\int_{L_1}----\int_{L_r}\psi(\xi_1,---,\xi_r)\phi_1(\xi_1)---\phi_r(\xi_r)\left(x_1\alpha^{v_1}\beta^{w_1}\right)^{\xi_1}--\left(x_r\alpha^{v_r}\beta^{w_r}\right)^{\xi_r}
$$

$$
\sum_{s=0}^{\infty}\frac{(-1)^s\Gamma(\rho+uk+u'k'+u_1\xi_1+-------+u_r\xi_r+l+t+1)(z-c)^{s+v}}{\Gamma(v)\Gamma(\rho+uk+u'k'+u_1\xi_1+----+u_r\xi_r+l+t-s+1)(s+v)s!}
$$

$$
\times\frac{\Gamma(\mu+wk+w'k'+w_1\xi_1+----+w_r\xi_r+1)}{\Gamma(\mu+wk+w'k'+w_1\xi_1+----+w_r\xi_r-t+1)}z^{\rho+uk+u'k'+u_1\xi_1---u_r\xi+l+t-s}\;d\xi_1---d\xi_r \quad \text{----(2.6)}
$$

Change of order in the above result produces

$$
\Theta=\sum_{l,t,s=0}^{\infty}\sum_{k=0}^{[n/m]}\sum_{k'=0}^{[n'/m']}\frac{(-n)_{mk}(-n')_{m'k'}\;A_{n,k}A'_{n',k'}}{k!\,k'!\,l!\,t!}a^k b^{k'}\alpha^{\sigma+vk+v'k'-l}\beta^{\mu+wk+w'k'-t}
$$

$$
(-1)^s(z-c)^{s+v}z^{\rho+uk+u'k'+u_1\xi\;+-------+u_r\xi_r+l+t-s}
$$

$$
\frac{1}{(2\pi\omega)^r}\int_{L_1}----\int_{L_r}\psi(\xi_1,---,\xi_r)\phi_1(\xi_1)---\phi_r(\xi_r)\left(x_1\alpha^{v_1}\beta^{w_1}\right)^{\xi_1}-\left(x_r\alpha^{v_r}\beta^{w_r}\right)^{\xi_r}
$$

$$
\frac{\Gamma(\rho+uk+u'k'+u_1\xi_1+----+u_r\xi_r+l+t+1)}{\Gamma(\rho+uk+u'k'+u_1\xi_1+----+u_r\xi_r+l+t-s+1)}d\xi_1----d\xi_r. \quad \text{--------------(2.7)}
$$

Changing the order of $\xi_i$ -integrals, and interpreting the multiple Mellin–Barnes Contour integrals obtained in terms of H–Function of r–variables, we can deduce the result (2.1).

Result (2.1) can also be written in following form

$$
I_z^v\{z^{\rho}(z+\alpha)^{\sigma}(z+\beta)^{\mu}S_n^m\left[az^u(z+\alpha)^v(z+\beta)^w\right]S_{n'}^{m'}\left[bz^{u'}(z+\alpha)^{v'}(z+\beta)^{w'}\right]
$$

$$
\times H\left[x_1z^{u_1}(z+\alpha)^{v_1}(z+\beta)^{w_1},---,x_rz^{u_r}(z+\alpha)^{v_r}(z+\beta)^{w_r}\right]\}
$$

$$
=\alpha^{\sigma}\beta^{\mu}z^{\rho+v}\sum_{l,t=0}^{\infty}\sum_{k=0}^{[n/m]}\sum_{k'=0}^{[n'/m']}\frac{(-n)_{mk}(-n')_{m'k'}A_{n,k}A_{n',k'}a^k b^{k'}\alpha^{vk+v'k'-l}\beta^{wk+w'k'-t}\;z^{uk+u'k'+l+t}}{k!\,k'!\,l!\,t!}
$$

$$\times \mathrm{H}^{0,N+3:*}_{P+3,Q+3:*}\left[\begin{array}{c} x_1\alpha^{v_1}\beta^{w_1}z^{u_1} \\ x_r\alpha^{v_r}\beta^{w_r}z^{u_r}\end{array}\middle| \begin{array}{l}(-\rho-uk-u'k'-l-t;u_1--u_r), \\ (-v-\rho-uk-u'k'-l-t;u_1--u_r),\end{array}\right.$$

$$\left.\begin{array}{l}(-\sigma-vk-v'k';v_1--v_r),(-\mu-wk-w'k';w_1--w_r),(a_j:\alpha'_j,\text{---},\alpha_j^{(r)})_{1,P}:* \\ (l-\sigma-vk-v'k';v_1--v_r),(t-\mu-wk-w'k';w_1--w_r),(b_j:\beta'_j,\text{---},\beta_j^{(r)})_{1,Q}:*\end{array}\right] \text{------- (2.8)}$$

by the application of following formula

$$\sum_{s=0}^{\infty}\frac{(-1)^s}{\Gamma(v)(s+v)\,s!}\mathrm{H}^{o,N\ :*}_{P,Q+1\ :*}\left[\begin{array}{c} z_1 \\ z_r\end{array}\middle| \begin{array}{ll}(a_{j;}\alpha'_j,---,\alpha_j^{(r)})_{1,P} & :* \\ (s-k;u_1,\text{---},u_r),(b_j;\beta'_j,---,\beta_j^{(r)})_{1,Q} & :*\end{array}\right]$$

$$=\mathrm{H}^{o,N:*}_{P,Q+1:*}\left[\begin{array}{c} z_1 \\ z_r\end{array}\middle| \begin{array}{ll}(a_j;\alpha'_j,\text{---},\alpha_j^{(r)})_{1,P} & :* \\ (-v-k;u_1,---,u_r),(b_j;\beta_j,---,\beta_j^{(r)})_{1,Q} & :*\end{array}\right]$$

Now we shall prove the fractional integral formula

$$I_z^{\eta,v}\{z^{\rho}(z+\alpha)^{\sigma}(z+\beta)^{\mu}S_n^m\left[az^u(z+\alpha)^v(z+\beta)^w\right]S_{n'}^{m'}\left[bz^{u'}(z+\alpha)^{v'}(z+\beta)^{w'}\right]$$

$$\times\mathrm{H}\left[x_1z^{u_1}(z+\alpha)^{v_1}(z+\beta)^{w_1},---,x_rz^{u_r}(z+\alpha)^{v_r}(z+\beta)^{w_r}\right]\}$$

$$=\alpha^{\sigma}\beta^{\mu}z^{\rho}\sum_{l,t=0}^{\infty}\sum_{k=0}^{\infty}\sum_{k=0}^{[n/m]}\sum_{k'=0}^{[n'/m']}$$

$$\frac{(-n)_{mk}(-n')_{m'k'}A_{n,k}A_{n',k'}a^kb^{k'}\alpha^{vk+v'k'-l}\beta^{wk+w'k'-t}\ z^{uk+u'k'+l+t}}{k!\,k'!\,l!\,t!}$$

$$\times \mathrm{H}^{0,N+3:*}_{P+3,Q+3:*}\left[\begin{array}{c} x_1\alpha^{v_1}\beta^{w_1}z^{u_1} \\ x_r\alpha^{v_r}\beta^{w_r}z^{u_r}\end{array}\middle| \begin{array}{l}(1-\eta-\rho-uk-u'k'-l-t;u_1--u_r), \\ (-v+1-\eta-\rho-uk-u'k'-l-t;u_1--u_r),\end{array}\right.$$

$$\left.\begin{array}{l}(-\sigma-vk-v'k';v_1--v_r),(-\mu-wk-w'k';w_1--w_r),(a_j:\alpha'_j,\text{---},\alpha_j^{(r)})_{1,P}:* \\ (l-\sigma-vk-v'k';v_1--v_r),(t-\mu-wk-w'k';w_1--w_r),(b_j:\beta'_j,\text{---},\beta_j^{(r)})_{1,Q}:*\end{array}\right] \text{--(2.9)}$$

where $\eta>0,\mathrm{Re}(\rho)+\sum_{i=1}^{r}u_i\min_{1<j\le m(i)}\left[\mathrm{Re}\left(\frac{d_j^{(i)}}{\delta_j^{(i)}}\right)\right]>-\eta,$

**Proof-**

Proceeding on the similar lines as adopted in the proof of the previous result and using

$$I_z^{\eta,v}\{z^{\lambda}\}=\frac{\Gamma(\lambda+\eta)}{\Gamma(\lambda+\eta+v)}z^{\lambda},\mathrm{Re}(\lambda)>-\eta \quad \text{------------ (2.10)}$$

we can generate the result (2.9).

## 3. SPECIAL CASES

(1) Substitution of $\mu = 0, w_i = 0\ (i = 1 --- r), m' = n' = 0$ in our integral formula (2.9) directly produces following result

$$I_z^{nv}\{z^{\rho}(z+\alpha)^{\sigma} S_n^m\left[az^u(z+\alpha)^v\right]$$

$$\times \mathrm{H}\left[x_1 z^{u_1}(z+\alpha)^{v_1} ---- x_r z^{u_r}(z+\alpha)^{v_r}\right]\}$$

$$= \alpha^{\sigma} z^{\rho} \sum_{l=0}^{\infty} \sum_{k=0}^{[n/m]} \frac{(-n)_{mk} A_{n,k} a^k \alpha^{vk-1} z^{uk+1}}{k!\ l!}$$

$$\times \mathrm{H}_{P+2,Q+2:*}^{0,N+2:*}\left[\begin{matrix} x_1\alpha^{v_1} z^{u_1} \\ x_r\alpha^{v_r} z^{u_r}\end{matrix}\middle| \begin{matrix}(-\sigma - vk; v_1 -- v_r), \\ (1-\sigma - vk; v_1 -- v_r),\end{matrix}\right.$$

$$\left.\begin{matrix}(1-\eta-\rho-uk-l; u_1 -- u_r), \left(a_j : \alpha'_j, ---, \alpha_j^{(r)}\right)_{1,P} : * \\ (-v+1-\sigma-\rho-uk-l; u_1 -- u_r),, \left(b_j : \beta'_j, ---, \beta_j^{(r)}\right)_{1,Q} : *\end{matrix}\right] \text{-------------------- (3.1)}$$

which has been obtained earlier by Gupta & Agarawal [2].

(2) If we put $\mu = 0, n = 0, n' = 0$ *and* $w_i = 0 (i = 1, -- r)$ *in* (2.8) ,we get a result which is in essence the same as obtained by Srivastava et al [11]

(3) If we take $a = u = 1, v = w = 0, m = 1,\ A_{n,k} = \binom{n+\gamma}{n}\frac{1}{(\gamma+1)^k}$

$b = u' = 1, v' = w' = 2,\ A'_{n',k'} = (-1)^{k'}$ in equation (2.8) and use result of Singh et al[7], we shall have

$$I_z^v\{z^{\rho+n'/2}(z+\alpha)^{\sigma}(z+\beta)^{\mu} L_n^{(r)}(z) H_{n'}(\tfrac{1}{2\sqrt{2}}) H\left[x_1 z_1^{u_1}(z+\alpha)^{v_1}(z+\beta)^{w_1}, ---, x_r z^{u_r}(z+\alpha)^{v_r}(z+\beta)^{w_r}\right]\}$$

$$= \alpha^{\sigma}\beta^{\mu} z^{\rho+v} \sum_{l,t=0}^{\infty} \sum_{k=0}^{n} \sum_{k'=0}^{[n'/2]} \frac{(-n)_k(-n')_{2k'}}{k!\,k'!\,l!\,t!}\binom{n+\gamma}{n}\frac{1}{(\gamma+1)_k}(-1)^k \alpha^{-l}\beta^{-t} z^{k+k'+l+t}$$

$$\times \mathrm{H}_{P+3,Q+3:*}^{N,Q+3:*}\left[\begin{matrix} x_1\alpha^{v_1}\beta^{w_1} z^{u_1} \\ x_r\alpha^{v_r}\beta^{w_r} z^{u_r}\end{matrix}\middle| \begin{matrix}(-\rho-k-k'-l-t; u_1 -- u_r), \\ (-v-\rho-k-k'-l-t; u_1 -- u_r),\end{matrix}\right.$$

$$\left.\begin{matrix}(-\sigma; v_1, ---, v_r), (-\mu; w_1, ---, w_r), \left(a_j : \alpha'_j, ---, \alpha_j^{(r)}\right)_{1,P} : * \\ (l-\sigma; v_1 -- v_r), (t-\mu; w_1 -- w_r), \left(b_j : \beta'_j, ---, \beta_j^{(r)}\right)_{1,Q} : *\end{matrix}\right] \text{--------------- (3.2),}$$

which is in conformity with the result (2.1).

(4) Substitution of $m' = n' = k' = 0$ *and* $w_i = 0 (i = 1, --- r)$ in equation (2.1) yields one another result of Gupta et al [2].

## REFERENCES

[1] Chen, M.P., Srivastava, H.M. and Yu, C.S(1998) Some operators of fractional calculus and their applications involving a new class of analytic function,Appl.Math.Comt.91, 285-296.

[2] Gupta, K.C. and Agrawal, S.M.(1989) Fractional integral formulae involving a general class of polynomials and the multivariable H-functions, Proc. Indian Acad. Sci.(math.sci) 99, 169-173.

[3] Gupta,K.C.&.Soni, R.C.(2002) A study of H-function of one and several variables, J.Rajashthan Acad, Phys,sci.1,89-94.

[4] Lin, S.D., Tu, S.T. and Srivastava, H.M.(2001) New generating function for a class of generalized Hermite Polynomials, J.Math.Anal.Appl.261,479-496.

[5] Lin,S.D., Shyu, J.C.,Nishimoto, K. and Srivatava, H.M. (2004) Explicit solutions of some general families of ordinary and Partial differential equations associated with the Bessel Equation, by means of fractional calculus, J.Fract.Calc.25.33-45.

[6] Ross, B. (1975) Fractional calculus and its applications, Lecture notes in math, vol, 457, Springer- Verlag , New York.

[7] Singh, N.P., Srivastava, H.M. (1982) Rend, Circ, math, Palermo(2), 32, 157-87.

[8] Srivastava, H.M.(1972)Indian J.Math.Vol,14,pp.1-6.

[9] Srivastava, H.M. and Panda, R.(1976) Some bilateral generating function for a class of generalized hypergeometric polynomials, J. Reine Angew Math, 283/284. 265-276.

[10] Srivastava, H.M., Chandel,R.S. and.Vishwakarma, P.K.(1994) Fractional derivatives of certain generalized hypergeometric functions of several variables, J. Math, Anal, Appl.184, 560-572.

[11] Srivatava, H.M., Goyal, S.P. (1995) J.Math.Anal Appl 112, 641-51.

[12] Srivatava, H.M.(2003) Fractional calculus and its applications, Cubo, Mat. Ed. 5, 33-48.

[13] Saigo, M.,Rana, R.K.(1988) Fractional calculus operators associated with a general class of polynomials, Fukuoka Univ. Sci. Reports 18, 15-22.

[14] Soni, R.C. and Singh Deepika (2002) Certain fractional derivatives formulae involving the product of a general class of polynomials and the multivariable H-functions, Proc. Indian Acad.Sci. (Math.Sci) vol 112, no 4, pp. 551-562.