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Curvature Tensor on Para-Sasakian Manifold admitting Quarter Symmetric Metric Connection

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Abstract : *The object of this paper is to study some curvature property of para-sasakian manifold with quarter symmetric metric connection and also we establish some theorems of different kinds of curvature tensor.*
Keywords: *Para-sasakian manifold, Quarter-symmetric meric connection, conformal, conharmonic, concircular, projective , pseudo projective, m-projective and Ricci curvature tensor.*

I. Introduction

In the study of quarter symmetric linear connection on a differentiable manifold, a linear connection $\tilde{\nabla}$ in an n dimensional manifold is said to be a quarter-symmetric connection if torsion tensor τ of the form $\tau(X,Y)=\tilde{\nabla}_X Y-\tilde{\nabla}_Y X-[X,Y]=\eta(Y)\phi X-\eta(X)\phi Y$. (1.1)

Where η is a 1-form and ϕ is a tensor of type $(1,1)$. In particular, If $\phi X = X$ and $\phi Y = Y$ then the quarter symmetric metric connection reduces to a semi symmetric metric connection which is the generalize case of quarter symmetric metric connection.

If the quarter symmetric metric connection $\tilde{\nabla}$ satisfies the condition $\tilde{\nabla}_X g(Y,Z)=0$ for all X,Y,Z $\in T(V_n)$, where $T(V_n)$is the Lie algebra of vector field on the manifold V_n, then $\tilde{\nabla}$ is said to be a quarter symmetric metric connection. In this paper we discuss the different type of curvature tensor with Quarter symmetric metric connection in Para- Sasakian Manifold. After preliminaries and about quarter symmetric metric connection , In section 4 we study some curvature tensor of Para-Sasakian manifold with Quarter symmetric metric connection .In section 5,6,7,8,9,10 we study about the Projective tensor, Conformal curvature tensor , Concircular curvature Tensor , Conharmonic curvature tensor, Pseudo Projective curvature tensor and m-Projective curvature tensor respectively. After that in section 11 we study about the skew-symmetric condition of Ricci tensor of $\tilde{\nabla}$ in a Para-Sasakian manifold, In section 12 we study about the skew-symmetric properties of projective Ricci tensor with respect to Quarter symmetric metric connection $\tilde{\nabla}$ in a Para-Sasakian manifold, In section 13 we study about the Einstein manifold with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ in a Para-Sasakian manifold.

II. Para-Sasakian Manifold

An n-dimensional differentiable manifold V_n (where $n=2m+1$) is called an almost paracontact manifold if it admits an almost paracontact structure (ϕ,ξ,η) consisting of a (1,1) tensor field ϕ, a vector field ξ and an 1-form η satisfying

$$\phi^2 X = X-\eta(X)\xi . \tag{2.1}$$

$$\eta(\xi)=1, \qquad \phi\xi=0, \qquad \eta(\phi X)=0 . \tag{2.2}$$

If g is a compatible Riemannian metric with (ϕ,ξ,η), that is

$$g(\phi X,\phi Y)=g(X,Y)-\eta(X)\eta(Y), \qquad \eta(X)=g(X,\xi). \tag{2.3}$$

$$g(\phi X,Y)=g(X,\phi Y). \tag{2.4}$$

For all vector field X,Y on V_n, then V_n becomes a almost paracontact Riemannian manifold equipped with an almost Para contact Riemannian structure . An almost paracontact Riemannian manifold is called Para-Sasakian manifold if it satisfies

$$(\nabla_X\phi)Y=-g(X,Y)\xi-\eta(Y)\phi X+2\eta(X)\eta(Y)\xi . \tag{2.5}$$

Where ∇ denotes the Riemannian connection of g .From the above equation it follows that

$$\nabla_X\xi=\phi X, (\nabla_X\eta)Y=g(X,\phi Y)=(\nabla_Y\eta)X . \tag{2.6}$$

In an n-dimensional Para-Sasakian manifold V_n. The following relation holds:

$$\eta(R(X,Y)Z) = \eta(Y)g(X,Z) - \eta(X)g(Y,Z). \tag{2.7}$$

$$R(X,Y)\xi = \eta(X)Y - \eta(Y)X. \tag{2.8}$$

$$R(\xi,X)Y = \eta(Y)X - g(X,Y)\xi. \tag{2.9}$$

$$S(X,\xi) = -(n-1)\eta(X), Q\xi = -(n-1)\xi. \tag{2.10}$$

$$S(\phi X,\phi Y) = S(X,Y) + (n-1)\eta(X)\eta(Y). \tag{2.11}$$

$$(\nabla_W R)(X,Y)\xi = g(\phi X,W)Y - g(\phi Y,W)X - R(X,Y)\phi W. \tag{2.12}$$

For any vector field X,Y,Z and W on V_n and R is the Riemannian curvature tensor and S is the Ricci tensor of type (0,2) such that $g(QX,Y) = S(X,Y)$., Q is the Ricci operator.

III. Quarter Symmetric Metric Connection

Let V_n be an n-dimensional Para-Sasakian manifold and ∇ be the Levi-civita connection on V_n. A Quarter symmetric metric connection $\tilde{\nabla}$ in a Para-Sasakian manifold is defined by

$$\tilde{\nabla}_X Y = \nabla_X Y + H(X,Y). \tag{3.1}$$

Where H is a tensor of type (1,1) such that

$$H(X,Y) = \frac{1}{2}[\tau(X,Y) + \tau'(X,Y) + \tau'(Y,X)]. \tag{3.2}$$

And

$$g(\tau'(X,Y),Z) = g(\tau(Z,X),Y). \tag{3.3}$$

From the equation (1.1) and (3.3), we get

$$\tau'(X,Y) = \eta(X)\phi Y - g(\phi X,Y)\xi. \tag{3.4}$$

By using equation (1.1) and (3.4) in (3.2) , we get

$$H(X,Y) = \eta(Y)\phi X - g(\phi X,Y)\xi. \tag{3.5}$$

Hence a quarter symmetric metric metric connection $\tilde{\nabla}$ in a Para-sasakian manifold is given by

$$\tilde{\nabla}_X Y = \nabla_X Y + \eta(Y)\phi X - g(\phi X,Y)\xi. \tag{3.6}$$

If R and $\tilde{R}$ are the curvature tensor of Levi-civita connection ∇ and the quarter symmetric metric connection $\tilde{\nabla}$ in a para-sasakian manifold then we have

$$\tilde{R}(X,Y)Z = R(X,Y)Z + 3g(\phi X,Z)\phi Y - 3g(\phi Y,Z)\phi X + [\eta(X)Y - \eta(Y)X]\eta(Z) - [\eta(X)g(Y,Z) - \eta(Y)g(X,Z)]\xi. \tag{3.7}$$

From the equation (3.7) we have

$$\tilde{S}(Y,Z) = S(Y,Z) + 2g(Y,Z) - (n+1)\eta(Y)\eta(Z). \tag{3.8}$$

Where $\tilde{S}$ and S are the Ricci tensor of a Para-Sasakian manifold with respect to the quarter-symmetric metric connection and Levi-civita connection respectively. Also from equation (3.8),we get

$$\tilde{r} = r + (n-1). \tag{3.9}$$

Where $\tilde{r}$ and r are the scalar curvature with respect to the quarter symmetric and Levi-civita connection respectively.

IV. Some Curvature Properties Of Para-Sasakian Manifold With Respect To Quarter Symmetric Metric Connection

Let K and $\tilde{K}$ be the curvature tensor of type (0,4) given by

$$K(X,Y,Z,U) = g(R(X,Y)Z,U).$$

$$\tilde{K}(X,Y,Z,U) = g(\tilde{R}(X,Y)Z,U).$$

Theorem 1: In Para-Sasakian manifold with Quarter symmetric metric connection $\tilde{\nabla}$, we have

$$\tilde{R}(X,Y)Z + \tilde{R}(Y,Z)X + \tilde{R}(Z,X)Y = 0. \tag{4.1}$$

$$\tilde{K}(X,Y,Z,U) + \tilde{K}(Y,X,Z,U) = 0. \tag{4.2}$$

$$\tilde{K}(X,Y,Z,U) + \tilde{K}(X,Y,U,Z) = 0. \tag{4.3}$$

$$\tilde{K}(X,Y,Z,U) - \tilde{K}(Z,U,X,Y) = 0. \tag{4.4}$$

Proof: Using equation (3.7) and first Binachi identity
$R(X,Y)Z + R(Y,Z)X + R(Z,X)Y = 0$.
With respect to Levi-civita connection ∇ ,we will get (4.1).
From (3.7) we have
$$\tilde{K}(X,Y,Z,U) = K(X,Y,Z,U) + 3g(\phi X,Z)g(\phi Y,U) - 3g(\phi Y,Z)g(\phi X,U).$$
$$+[\eta(X)g(Y,U) - \eta(Y)g(X,U)]\eta(Z) - [\eta(X)g(Y,Z) - \eta(Y)g(X,Z)]g(\xi,U). \quad (4.5)$$
Since $K(X,Y,Z,U) = -K(Y,X,Z,U)$. (4.6)
By using equation (4.5) and (4.6) we get(4.2).
By using equation (3.7) ,(4.5) and $K(X,Y,Z,U) = -K(X,Y,U,Z)$ we get (4.3).
Similarly from equation (3.7) , (4.5) and the equation $K(X,Y,Z,U) = K(U,Z,X,Y)$ we get (4.4).

Theorem 2: Let V_n be an n-dimensional Para-Sasakian manifold with Quarter symmetric metric connection $\tilde{\nabla}$ then we have
$$\tilde{R}(\xi,X)\xi = 2R(\xi,X)\xi. \quad (4.7)$$
$$\tilde{R}(X,Y)\xi = 2R(X,Y)\xi. \quad (4.8)$$
$$\tilde{R}(\xi,X)Y = 2R(\xi,X)Y. \quad (4.9)$$

Proof : Using (3.7) and (2.9), we get (4.9), similarly using (3.7) and (2.8) , we get (4.10), and using (3.7) and (2.9) , we get (4.11).

V. Projective Curvature

Let V_n be an n-dimensional Para-Sasakian manifold. The projective curvature tensor of V_n with respect to Quarter symmetric metric connection $\tilde{\nabla}$ is defined by
$$\tilde{P}(X,Y)Z = \tilde{R}(X,Y)Z - \frac{1}{(n-1)}\{\tilde{S}(Y,Z)X - \tilde{S}(X,Z)Y\}. \quad (5.1)$$
By using equation (3.7), (3.8) and (5.1), we get
$$\tilde{P}(X,Y)Z = P(X,Y)Z + 3g(\phi X,Z)\phi Y - 3g(\phi Y,Z)\phi X - [\eta(X)g(Y,Z) - \eta(Y)g(X,Z)]\xi - \frac{2}{(n-1)}\{g(Y,Z)X - g(X,Z)Y\}$$
$$+ n\{\eta(Y)X - \eta(X)Y\}\eta(Z). \quad (5.2)$$
From (5.2),we get
$$\tilde{P}(X,Y)Z + \tilde{P}(Y,Z)X + \tilde{P}(Z,X)Y = 0. \quad (5.3)$$

Hence we can state the following:

Theorem 3: Let V_n be an n-dimensional Para-Sasakian manifold with Quarter-symmetric metric connection $\tilde{\nabla}$, then the projective curvature tensor of V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is cyclic.

VI. Conformal Curvature Tensor

Let V_n be an n-dimensional Para-Sasakian manifold .The conformal curvature tensor V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is defined by
$$\tilde{C}(X,Y,Z,U) = \tilde{K}(X,Y,Z,U) - \frac{1}{(n-2)}\{g(Y,Z)\tilde{S}(X,U) - g(X,Z)\tilde{S}(Y,U) + g(X,U)\tilde{S}(Y,Z) - g(Y,U)\tilde{S}(X,Z)\}$$
$$+ \frac{\tilde{r}}{(n-1)(n-2)}\{g(Y,Z)g(X,U) - g(X,Z)g(Y,U)\}. \quad (6.1)$$
If $\tilde{S} = 0$ then (6.1) gives
$$\tilde{C}(X,Y,Z,U) = \tilde{K}(X,Y,Z,U). \quad (6.2)$$
Thus we have :

Theorem 4: If in a Para-Sasakian manifold the Ricci tensor of a Quarter symmetric metric connection $\tilde{\nabla}$ vanishes, then the curvature tensor of $\tilde{\nabla}$ is equal to the conformal curvature tensor of the quarter symmetric manifold.

So from equation (4.2) and (6.2), we get

$$\tilde{C}(X,Y,Z,U)+\tilde{C}(Y,X,Z,U)=0. \tag{6.3}$$

VII. Concircular Curvature Tensor

Let V_n be an n-dimensional Para-Sasakian manifold .The concircular curvature tensor of V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is defined by

$$\tilde{Z}(X,Y)U=\tilde{R}(X,Y)U-\frac{\tilde{r}}{n(n-1)}[g(Y,U)X-g(X,U)Y]. \tag{7.1}$$

By using equation (7.1) and (4.1), we get

$$\tilde{Z}(X,Y)U+\tilde{Z}(Y,U)X+\tilde{Z}(U,X)Y=0. \tag{7.2}$$

This leads to the following:

Theorem 5: Let V_n be an n-dimensional Para-Sasakian manifold with Quarter-symmetric metric connection $\tilde{\nabla}$, then the concircular curvature tensor of V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is cyclic.

VIII. Conharmonic Curvature Tensor

Let V_n be an n-dimensional Para-Sasakian manifold .The conharmonic curvature tensor of V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is defined by

$$\tilde{V}(X,Y,Z,U)=\tilde{K}(X,Y,Z,U)-\frac{1}{(n-2)}\{\tilde{S}(Y,Z)g(X,U)-\tilde{S}(X,Z)g(Y,U)+\tilde{S}(X,U)g(Y,Z)-\tilde{S}(Y,U)g(X,Z)\}. \tag{8.1}$$

If $\tilde{S}=0$, (8.1) gives

$$\tilde{V}(X,Y,Z,U)=\tilde{K}(X,Y,Z,U). \tag{8.2}$$

By using equation (4.2) and (8.2), we get

$$\tilde{V}(X,Y,Z,U)+\tilde{V}(Y,X,Z,U)=0.$$

Again from equation (6.2) and (8.2), we get

$$\tilde{V}(X,Y,Z,U)=\tilde{C}(X,Y,Z,U).$$

Hence we can state the following:

Theorem 6: In an para-Sasakian manifold the Ricci tensor of a Quarter symmetric metric connection $\tilde{\nabla}$ vanishes, then the conformal curvature tensor is equal to conharmonic curvature tensor of the quarter symmetric manifold.

IX. Pseudo Projective Curvature Tensor

Let V_n be an n-dimensional Para-Sasakian manifold .The Pseudo projective curvature tensor of V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is defined by

$$\tilde{\bar{P}}(X,Y)Z=a\tilde{R}(X,Y)Z+b[\tilde{S}(Y,Z)X-\tilde{S}(X,Z)Y]-\frac{\tilde{r}}{n}\left\{\frac{a}{(n-1)}+b\right\}[g(Y,Z)X-g(X,Z)Y]. \tag{9.1}$$

Where a and b are constant such that $a,b\neq 0$

By using equation (3.7), (3.8), (3.9) in (9.1), we get

$$\tilde{\bar{P}}(X,Y)Z=aR(X,Y)Z+3ag(\phi X,Z)\phi Y-3ag(\phi Y,Z)\phi X+a[\eta(X)Y-\eta(Y)X]\eta(Z)-a[\eta(X)g(Y,Z)-\eta(Y)g(X,Z)]\xi$$
$$+b[\{S(Y,Z)+3g(Y,Z)-(n+1)\eta(Y)\eta(Z)\}-\{S(X,Z)+2g(X,Z)-(n+1)\eta(X)\eta(Z)\}]-\left(\frac{r+(n-1)}{n}\right)\left\{\frac{a}{(n-1)}+b\right\}[g(Y,Z)X-g(X,Z)Y]. \tag{9.2}$$

Using first Binachi identity in (9.2), we get

$$\tilde{\bar{P}}(X,Y)Z+\tilde{\bar{P}}(Y,Z)X+\tilde{\bar{P}}(Z,X)Y=0,$$

Hence we can state the following:

Theorem 7: In Para-Sasakian manifold with Quarter-symmetric metric connection $\tilde{\nabla}$, the Pseudo projective curvature tensor of V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is cyclic.

X. M- Projective Curvature Tensor

Let V_n be an n-dimensional Para-Sasakian manifold with Quarter-symmetric metric connection ,then the m- projective curvature tensor of V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is defined by

$$\tilde{W}^*(X,Y)Z = \tilde{R}(X,Y)Z - \frac{1}{2(n-1)}\left[\tilde{S}(Y,Z)X - \tilde{S}(X,Z)Y + g(Y,Z)\overline{Q}X - g(X,Z)\overline{Q}Y\right]. \tag{10.1}$$

From equation (3.7),(3.8) and (10.1), we get

$$\tilde{W}^*(X,Y)Z + \tilde{W}^*(Y,Z)X + \tilde{W}^*(Z,X)Y = 0. \tag{10.2}$$

Hence we can state that

Theorem 8: In Para-Sasakian manifold with Quarter-symmetric metric connection $\tilde{\nabla}$, the m- projective curvature tensor of V_n with respect to Quarter-symmetric metric connection $\tilde{\nabla}$ is cyclic.

XI. Skew Symmetric Condition Of Ricci Tensor Of $\tilde{\nabla}$ In A Para-Sasakian Manifold

From equation (3.8), we get

$$\tilde{S}(Y,Z) = S(Y,Z) + 2g(Y,Z) - (n+1)\eta(Y)\eta(Z). \tag{11.1}$$

And

$$\tilde{S}(Z,Y) = S(Z,Y) + 2g(Z,Y) - (n+1)\eta(Z)\eta(Y). \tag{11.2}$$

By using equation (3.8) and (11.2), we get

$$\tilde{S}(Y,Z) + \tilde{S}(Z,Y) = 2S(Y,Z) + 4g(Y,Z) - 2(n+1)\eta(Y)\eta(Z). \tag{11.3}$$

If $\tilde{S}(Y,Z)$ is skew symmetric then the left hand side of equation (11.3) vanishes and we get

$$S(Y,Z) = (n+1)\eta(Y)\eta(Z) - 2g(Y,Z). \tag{11.4}$$

Moreover if $S(Y,Z)$ is given by (11.4), then from (11.3), we get

$$\tilde{S}(Y,Z) + \tilde{S}(Z,Y) = 0.$$

Hence we can state the following theorem

Theorem 9: If a para-sasakian manifold admits a quarter symmetric metric connection $\tilde{\nabla}$ then a necessary and sufficient condition for Ricci tensor of $\tilde{\nabla}$ to be skew-symmetric is that the Ricci tensor of Levi-civita connection ∇ is given by (11.4).

XII. Skew Symmetric Condition Of Projetive Ricci Tensor With Respect To Quarter Symmetric Metric Connection $\tilde{\nabla}$ In A Para-Sasakian Manifold

Projective Ricci tensor in a Riemannian manifold is defined as follows

$$P(X,Y) = \frac{n}{(n-1)}\left[S(X,Y) - \frac{r}{n}g(X,Y)\right] \tag{12.1}$$

Analogous to this definition we define Projective Ricci tensor with respect to Quarter symmetric metric connection $\tilde{\nabla}$ is given by

$$\tilde{P}(X,Y)=\frac{n}{(n-1)}\left[\tilde{S}(X,Y)-\frac{\bar{r}}{n}g(X,Y)\right]. \tag{12.2}$$

By using equation (3.8), (3.9) and (12.2), we get

$$\tilde{P}(X,Y)=\frac{n}{(n-1)}\left[S(X,Y)+2g(X,Y)-(n+1)\eta(X)\eta(Y)-\left\{\frac{r+(n-1)}{n}\right\}g(X,Y)\right]. \tag{12.3}$$

From (12.3), we get

$$\tilde{P}(Y,X)=\frac{n}{(n-1)}\left[S(Y,X)+2g(Y,X)-(n+1)\eta(Y)\eta(X)-\left\{\frac{r+(n-1)}{n}\right\}g(Y,X)\right]. \tag{12.4}$$

From equation (12.3) and (12.4), we get

$$\tilde{P}(X,Y)+\tilde{P}(Y,X)=\frac{n}{(n-1)}\left[2S(X,Y)+2\left(\frac{n-r+1}{n}\right)g(X,Y)-2(n+1)\eta(X)\eta(Y)\right]. \tag{12.5}$$

If $\tilde{P}(X,Y)$ is skew symmetric then the left hand side of equation (12.5) vanishes and we get

$$S(X,Y)=(n+1)\eta(X)\eta(Y)-\left(\frac{n-r+1}{n}\right)g(X,Y). \tag{12.6}$$

Moreover if $S(X,Y)$ is given by (12.6) then from (12.5), we get

$$\tilde{P}(X,Y)+\tilde{P}(Y,X)=0 .$$

So projective Ricci tensor of $\tilde{\nabla}$ is skew symmetric .hence we state the following theorem.

Theorem 10: If a para-sasakian manifold admits a quarter symmetric metric connection $\tilde{\nabla}$ then a necessary and sufficient condition for the projective Ricci tensor of $\tilde{\nabla}$ to be skew-symmetric is that the Ricci tensor of Levi-civita connection ∇ is given by (12.6).

XIII. Einstein Manifold With Respect To Quarter Symmetric Metric Connection $\tilde{\nabla}$ In A Para-Sasakian Manifold

A Riemannian manifold V_n is called an Einstein manifold with respect to Riemannian connection if

$$S(X,Y)=\frac{r}{n}g(X,Y). \tag{13.1}$$

Analogous to this definition , we define Einstein manifold with respect to Quarter symmetric metric connection $\tilde{\nabla}$ by

$$\tilde{S}(X,Y)=\frac{\tilde{r}}{n}g(X,Y). \tag{13.2}$$

By using equation (3.8), (3.9) and (13.2), we get

$$\tilde{S}(X,Y)-\frac{\tilde{r}}{n}g(X,Y)=S(X,Y)-\frac{r}{n}g(X,Y)+\frac{(n+1)}{n}g(X,Y)-(n+1)\eta(X)\eta(Y). \tag{13.3}$$

If $g(X,Y)=n\eta(X)\eta(Y)$. (13.4)

Then from equation (13.3), we get

$$\tilde{S}(X,Y)-\frac{\tilde{r}}{n}g(X,Y)=S(X,Y)-\frac{r}{n}g(X,Y). \quad (13.5)$$

Hence we can state the following theorem

Theorem 11: In a para-sasakian manifold with quarter y symmetric connection if the relation (13.4) hold, then the manifold is an Einstein manifold for the Riemannian connection iff it is an Einstein manifold for the connection $\tilde{\nabla}$.

References

Journal Papers:

[1] A.A.Shaikh and S.K.Jana, Quarter symmetric metric connection on a $(\kappa-\mu)-$contact metric manifold, Commun. Fac. Sci.Univ.Ank.Series A1, 55, 2006, 33-45.

[2] A.K.Mondal and U.C.De, Some properties of a quarter symmetric metric connection on a sasakian manifold, Bull. Math. Analysis Appl., 1(3), 2009, 99-108.

[3] D.G.Prakasha, On $\phi-$symmetric Kenmotsu manifold with respect to quarter symmetric metric connection, Int. Electronic J.Geom, 4(1), 2011, 88-96.

[4] K.Yano and T. Imai, , Quarter symmetric metric connection and their curvature tensor, Tensors, N.S, 38, 1982, 13-18.

[5] Kumar, K.T. Pradeep, Venkatesh, and C.S.Bagawadi, On $\phi-$recurrent Para-sasakian manifold admitting quarter symmetric metric connection, ISRN Geometry, 2012, Article ID 317253.

[6] N.Pusic, On quarter symmetric metric connections on a hyperbolic Kaehlerian space, Publ. De L'Inst. Math.(Beograd), 73(87), 2003, 73-80.

[7] R.N. Singh and M.K. Pandey, On a type of quarter symmetric non-metric connection in a kenmotsu manifold, Bull. Cal. Math.Soc, 99(4), 2007, 433-444.

[8] S.K.Hui , On $\phi-$pseudo symmetric para-sasakian manifold, Acta Universities Apulensis, 39, 2014, 161-178.

[9] S.Golab ,On semi symmetric linear connections, Tensor.N.S.,29, 1975, 293-301.

[10] S. Mukhopadhyay, A.K.Roy, B.Barua, Some properties of a quarter symmetric metric connection on a Riemannian manifold, Soochow J.Math. 17, 1991, 205-211.

[11] S. sular , C. Ozgur and U.C. De, Quarter symmetric metric connection in a kenmotsu manifold, S.U.T.J. Math, 44, 2008, 297-308.

[12] S.S. Shukla and M.K. Shukla, On $\phi-$Ricci symmetric kenmotsu manifolds,Novi Sad J. Math., 39(2), 2009, 89-95.

[13] V.K.Jaiswal , R.H.Ojha, and B.Prasad, A semi-symmetric metric $\phi-$connectionin an LP-sasakian manifold, J.Nat. Acad.math, 15, 2001, 73-78.

Books:

[14] R.S.Mishra, A course in tensors with applications to Riemannian geometry, II edition Pothishala Pvt. Ltd. Allahabad (1973).

[15] R.S.Mishra, Structure on a differentiable manifold and there application. Chandrama Prakashan, Allahabad (1984).

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