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CROSS CULTURAL CONFLICTS IN JHUMPA LAHIRI`S *THE NAMESAKE*

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ABSTRACT

The objective of this paper is to bring forth the excellence of the author Jhumpa Lahiri, a Pulitzer Prize winner, with regard to her debut novel *The Namesake*. In this novel she fantastically explores the ambiguity of name and immigrant's emotional identity and also the cross cultural conflicts the immigrants face in their chosen land. Constantly moving between events in Calcutta, Boston, and New York City, the novel reveals the different issues involved in being caught between the two conflicting cultures with distinct religious, social and ideological differences.

Keywords: *Excellence, Emotional, , Traumatic, Hybridism, Hyphenated, Kindergarten, Graduation-Studies.*

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INTRODUCTION

Jhumpa Lahiri is one of the celebrated novelists with a lot of international fame and reputation to her credit. Her first novel *The Namesake* (2003), a major national bestseller, was named New York magazine book of the year. She searches deep in her characters and reveals their problems in an elaborate manner much to the amazement of the women. She stresses that migrations across nations lead to negotiation between cultures which finally paves the way for cultural hybridism and hyphenated identity. Most importantly the identity of the individual, which is constantly affected by the society, is a thing that has to be discovered by the process of reflections and negotiations. Here is a clear message to the third world people who wish to enter the first world without knowing that the displacement demands greater adaptability.

TOPIC IN DETAIL

Actually the novel *The Namesake* is the story of two generations of an Indian family and their struggle to adjust themselves in the west part of the world. One of the main characters, Ashima faces cultural traumatic experiences on many occasions. One of the problems she faces in naming of her first born child whom they call Gogol in the beginning. Naming is inevitable for the couple Ashoka and Ashima for the new born baby to be discharged from the hospital. Ashoke names the child after the Russian writer Nikolai Gogol as he is his favourite writer. Ashima too approves this because the name stands both for her son's life as well as her husband's.

When the boy is taken to kindergarten with the good name "Nikhil", Gogol decides to prefer his pet name by conveniently writing it in the registration form while filling it.

> "Ashoka and Ashima are shocked. What about the parent`s preference? Ashima and Ashok wonder, shaking their heads. But since neither of them feels comfortable pressing the issue, they have no choice but to give in". (*Namesake* 60)

The irony here is that, having been born to Indians and that too to Bengali parents; Gogol has to retain a Russian name in America. Secondly he is neither Indian nor American but Russian named after the Russian author who happens to be his father's favourite writer. The issue of his identity with his confusing name becomes even tougher when he attains youth. Continuously he suffers the problem of his name in his multi-cultural life.

One day when he happens to attend a panel discussion about Indian novels written in English, he comes to understand the distinctive definition of the cultural conflict he is facing. He arrives at a clear idea about ABCD, "American born confused *desi*''. He avoids, ABCD friends for they remind him too much of the way his parents choose to live, befriending people not so much because they like them but because of a past they happen to share. (119)

However, later on, his father tells him the truth of him being named so and instantly he accepts his name. Further when Gogol joins graduation-studies, surprisingly, he decides to

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change his name to Nikhil and he makes a conscious effort to be entirely different from his parents. He aspires to live in a different world totally free from Bengali Culture as the native traditions bind him down to a country and culture which is entirely foreign to him. He is not only confused about his name but also with the two opposite cultures that he lives and he is emotionally attached to. He repeatedly experiences a cultural conflict and dilemma on many occasions. Actually there are occasions when he goes for repentance for being a Diaspora personality, even though there is no fault of his in this whole act of being double-cultured.

As a result, he develops a strong urge to assimilate and be one among the American multitudes. He does not want to be known as a confused *deshi* or as an outsider to the country where he lives. He strongly feels that he is an American and only an American who wishes to run away himself from everything which is non-American. But Ashima, his mother constantly tries to bind him with Bengali tradition and culture on one hand and on the other tries he to be well equipped to assimilate in the host country since it helps his carrier growth. Though Gogol at heart hates it he has to give up his drawing class and attend Bengali Language classes on the request of his mother.

> "The drawing class is held on the top floor of the public library; on nice days they are taken for walks through the historic district, carrying large sketch pads and pencils,... Gogol can't help noticing, on paper that resembles the folded toilet paper he uses". (66)

In an alien land when the children grow older the cultural conflicts too raise and they torment them and it is certain to anybody. The adjustment and the question of survival and establishing their roots on the new soil become very difficult. Gogol dates with his girlfriend who appears strange to Ashima and Ashoka but for Gogol he is already too late to date with girls since many boys and girls of his age have already paired. When Gogol brings in his girlfriend Maxine to their house, he notices signs of disapproval from his parents.

At least Ashima is relieved on hearing from Gogol that he has not got thought of his marriage. When children turn sixteen they are no more under the control of their parents and their individuality dominates. Gogol too is totally confused between his 'Americanised Indian' and Indianised American identity, though he was born and raised in America.

Finding their children grow up in an undesirable way, the Gangulis try to pass on at least some part of Bengali culture to their children by exposing them to Bengali gatherings where in many Bengalis talk about their native place, the food and other issues related to Bengal will influence them. By doing so the Gangulis try to make the Bengali culture familiar to their children and make them realise that their roots are not only 'here but also there in India'. The text goes like this:

> "Still, they do what they can. They make appoint of driving in to Cambridge with the children when the Apu Triology palys at

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the Orson wells, or when there is Kathakali dance performance or a sitar recital at memorial Hall. (65).

Not surprisingly Ashima was very much affected when she finds that Gogol dates with the American girl Maxine and plans to spend his vacation with her parents. It becomes a heart breaking issue for her as she asks immediately:

"Why do you wait to tell us these things at the last minute?" what sort of vacations? What plans?"

When he compares his parents with Maxine's parents, Gogol understands that he has been leading a contrasted life. As,

"But their lives bear no resemblance to that of Gerald and Lydia : expensive pieces of Jewellery presented on Lydia's birthday, flowers brought home for no reason at all, the two of them kissing openly, going for walks through the city, or to dinner, just as Gogol and Maxine do. Seeing the two of them curled up on the sofa in the evenings, Gerald's head resting on Lydia's shoulder, Gogol is reminded that in all his life he has never witnessed a single moment of physical affection between his parents". (138)

When the party is being celebrated, Gerald and Lydia

"Preside at the centre of their dinners, where as his parents behave more like caterers in their own home, solicitous and watchful." (141)

When Gogol and Maxine are on the way to Massachusetts, he says to her,

"Things he figures she should know in advance that they will not be able to touch or kiss each other in front of his parents, that there will be no wine with lunch". (146)

The restrictions amuse Maxine as she enjoys the conversation with Gogol. Usually American parents never peep in to the personal affairs and freedom of their children. They give due respect to their privacy and individuality. On contrary Indian parents intervene at every juncture of their children's lives. Hence Gogol smoothly slides into Maxine's way of life. In one party Maxine approaches him and stretches her hand towards him as she is tired of her boy friend. The very next morning without pause, she invites him to dinner at her place. He enquires her whether her parents would mind his coming over there. Her responses in a typical American way:

"Why on earth would they mind?"(129)

Maxine's parents Gerald and Lydia's invite Gogol into their lives. So he becomes a frequent guest in their house. Gerald and Lydia are very busy with their issues. Gogol and Maxine come and go to movies and dinners as they please.

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> "They go to darkened humble looking restaurants downtown where the tables are tiny, the bills huge (136).

After his work Gogol visits to their house and sleeps with Maxine, Gerald and Lydia think nothing. Simultaneously Gogol falls in love with Maxine and automatically wishes to marry her. However Gogol's sense of responsibility ignites his cultural roots after his father's death and he ignores Maxine. Maxine too repents the truth that she cannot provide any solace to Gogol as she belongs to a different culture.

Even though Gogol gets accepted in Maxine's family it is difficult for Ashima and Ashok to invite her as her daughter in law.

> "By now Ashima knows that Gogol spends his nights with Maxine, sleep-in under same roof as her parents, a thing Ashima refuses to admit to her Bengali friends" (166)

Thus the first generation immigrants know about their roots but the second generation is in a state of confusion about their identity. Growing up in an alien country they imbibe most of its traits but still they are identified as Indians and not Americans. Though they are labelled as Indians, they don't have the firsthand experience of India and this makes their situation even worse. Sense of belongingness always haunts them. This quest puts them in a situation that they cannot run away from. By making frequent visits to Calcutta they try to find their roots of their native lands when Gogol is ten years old.

> "by the time he is ten he has been to Calcutta three more times, twice in summer and once during ***Durga puja*** and the most recent trip he still remembers the sight of it etched respectably into the white washed, exterior or his paternal grandparents house. He remembers the astonishment of seeing six pages full of Ganguli`s, three columns to a page, in the Calcutta telephone directory. (67)

Knowing the fact that the Gangaulis belong to Calcutta and that he is one of the few Gingilis living in America, Gogol becomes restless. He is able to identify himself with the host culture where he is born and brought up but is not able to identify himself with the Gngulis living in Calcutta.

One of the incidents in his life makes him aware that his roots are not here where he lives but in somewhere else. Once, during his project works, the peculiarity of his name becomes apparent. The students go the graveyard and he knows that he is different from his fellow students.

> To Gogol`s surprise they are told not to draw the grove stones, but to rub their surfaces..... Gogol is old enough to know that there is no Gangulis here. He is old enough to know that he himself will be burned, not buried, that his body will

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CONCLUSION

The basic question of identity is the real source of conflicts and it has even led to wars in the world's history. At the same time it is remains with the people who are lead their lives in two worlds at the same time. The most important thing is that the ambiguity of name cannot be answered just by changing the name on record. The multiple and diverse order one lives in today has put one in great problems in this globalized and multi-cultured world. Now-a-days, a globalized has already evolved and automatically it should combat with the world of heterogeneous societies who do not wish to transform quickly. Let one hope that this will come to an end soon and people forget certain elements of identify such as food, clothes, language, religion and other petty thengs. Only then can one lead a peaceful life in this multi-cultured practical society on a global space.

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Diaspora- A Complex Global Phenomenon

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It is to be observed that man is the most widely scattered social animal on the earth and therefore migration is a geographical phenomenon that seems to be an unavoidable part of human history. The shifting of people from their native culture through physical dislocation as refugees, immigrants, exiles or the colonizing imposition of a foreign culture - one can witness the displacement as the most determining experience of the century. Multi-culturalism and Multi-nationalism are common to the modern man because of globalization.

Indian migration is the most peaceful and effective migration which sets it apart from any other migrations. The first wave of migration started 5000 years ago by saints moving in various directions to spread knowledge. The second wave of migration was from Indian silk traders , and traders dealing with spices. The third wave of migration was during the British period in which labourers went to cultivate rubber sugarcane and tea. The last wave of Indian migration to the west started after independence and it was from well educated people. Many of these educated became citizens of the countries into which they had migrated. Today there are nearly twenty million people of Indian origin spread over one hundred and thirty six countries across the world. Through this one can say that the Indian Diaspora is perhaps the oldest Diaspora as far the History is concerned.

Suddenly Diaspora experiences have drawn attention all over the world. The word of Diaspora refers to the displaced communities of the people who have been migrated from their native place to the other world which cannot be termed as their own. The movements in Diaspora are not always involuntary. Most of the times people wish to lead a cosy life without giving impotence to their nativity or origin. And with this intension most of the Indians have settled permanently in

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other nations like America.

Recently the contribution of Indian Diaspora writers has been praiseworthy. Diaspora became a global issue for which much of the credit goes to the Indian Diaspora writers. The Diaspora Characters undergo certain traumatic experiences such as nostalgia, identity crisis, alienation, insider outsider syndrome and the process of assimilation. Most of these writers are either born in the United States or bread there. They are brought up in different cultures, different languages and different faiths. This results in a total multicultural lifestyle and this type of life style makes a central theme in many of the second generation writers.

If one observes the derivation of the word 'Diaspora', it takes its origin from the Greek word "Dia" (through) and "Sepiro" (Scatter) which literally means scattering or dispersion. The term was first used in the context of the experiences and predicament of the Jews who were rendered homeless after the Babylonian conquests. This term now shares meaning with large semantic domain that includes words like immigrant, expatriate, refugee, guest worker, exile community and ethnic community.

As Durham opines,

> "Diaspora suggests a dislocation from the nation-state or geographical location of origin and relocation in one or more states, territories or countries''. (Durham Peters, John, P.23).

Diaspora refers to the dislocation forced or voluntary of people from one or more nations, states to another. Robert Cohen describes Diasporas as the communities of people living together in one country who:

> "Acknowledge that the old country – a nation often buried deep in language, religion, custom or folklore always has some claim in their loyalty and emotions". (Cohen, Robert. P.9)

Diasporas thus live in one country and look across time and space to another. The immigrant Diasporas and their descendants obviously experience displacements, fragmentation, marginalization,

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rootlessness and discontinuity in the cultural 'discourse' of the subject countries. They carry abundance of cultural baggage with them throughout their journey. Therefore they have not only economic interest but also psychological as well as intellectual involvement in their countries of origin. In the absence of the home land, Diaspora community is instinctively in quest of some point in space to which it may emotionally belong. Thus the community longs for a space for it to be attached and enjoy the psychological advantage.

The term Diaspora has been differently defined by scholars of various schools of thought. Since time immemorial human races have travelled in search of achieving their desired goals or aspired ambitions. Sometimes they are forcefully migrated to the 'other lands' since they cannot survive in their local areas. Thus experience of Diaspora is a worldwide phenomenon. Diaspora is a mere extension of a particular community that lives outside its native land: hence any Diaspora group mirrors the image of native community it belongs to. It is not a mere foot print but a lively reflection of the community.

Systematic study of Diaspora communities is often known as Diasporology. It focuses on identification and evolution of cultural traits of a particular community or society. In addition to that such study reveals the strengths and weaknesses of a particular community by way of studying in comparison with the `insiders' and `outsiders' of a particular community on the basis of their achievements and failures.

As already mentioned, Diaspora persons are haunted by nostalgia for their original home and feel alienated and dislocated in the host land. Even then their return to the home land remains metaphorical. The Diaspora experiences include the quest for identity with all its cultural features. Marginalized in their adopted countries, Diasporas mainly face the crisis of identity, alienation and dislocation. In the case of Diasporas, it is not necessary that the mother land should be a real one and it may be even an imaginary one in many cases. The fact is that they psychologically need a land of their own, though imaginary. For instance the home land existed in the minds of the Jews scattered over several countries before the establishment of Israel.

It is not possible to express the Diaspora experiences in a simple way. It is a complex experience because it deals not only with the physical displacement of migrants from a place called home land,

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but also with the psychology of the dislocated persons; so it becomes a very complex phenomenon. To understand and analyse their experiences, one has to be aware of the role that their culture, language and idea of nation plays.

The Diaspora writings have different types of experiences to share with the world. One can observe a peculiar variedness in the expression of the experiences in the Diaspora writings. These are sense of footlessness, agony or pain of rising with homelessness, anxiety and neurosis in the foreign land and the nostalgia towards their home land. Despite the differences in their cultures and traditions, the migrants share the experiences of dislocation from their native land. The bond with one another is mainly on the basis of their similar status; that of migrants living on foreign lands and have consequently formed Diaspora communities.

The Diaspora writings are basically rooted in the native culture; hence the writings from specific areas with specific cultures try to portray the same in their writings. Such Diaspora experiences enrich their writings with emotional feelings. These writings are the creative outcome of conflict and instability that the writers must have experienced being migrants. This type of anxiousness of dislocation is the characteristic of the expatriate writers. The works of Diaspora writers are the results of their human conditions, sufferings, complexity of their vision and their ability to look forward without being able to forget the past.

Geoffrey Kain in his popular work, the *Ideas of Home; Literature of Asian Migration* presents the meaning of "home" as important for immigrants or exiles that come from a distant land to America, with the hope of freedom. Actually they want to fulfil their American Dream. America opens a door of hope for people from all over the world. In other words, America is reformed like a college with the multicultural aspects from the immigrant wave. America is like a kaleidoscope which is equipped with small coloured glasses in the tube; when the kaleidoscope turns, there are many different changing patterns mirrored.

Like their journey to a new land, there is a long process for the immigrants to find a home of their own. There will be a lot of

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parameters such as, racial issues and cultural differences in the procedures of home making calling a place home is forming a contact to the new place, and it ends a vagrant life for immigrants or exiles; therefore, when they attempt to establishing a home, is to seeking for a place to locate, to live in, and to get rooted in an alien place. Home for the immigrants not only a temporary place to occupy, but also a permanent position to stay in. Also when they quest for belonging in the new country, they are blocked between their old world and a new land.

One more interesting word is 'Displacement', which means movement of people from their native land to the adopted land carrying a bundle of beliefs, customs and traditions. Hence, one who is forced to leave one's native place, one is called a displaced person and this phenomenon is termed as 'forced migration'. Displacement is of two types, physical and physiological. Physical displacement means people who have left their home to settle in countries or cultural communities, which are basically quite strange to them. Moreover physiological displacement means diversion of mind.

Displacement is not the feeling of being at home, or not being at 'unhome' either. And it is living far away from home. When an individual lives in exile, he feels himself displaced and therefore he feels alienated. Likewise exile results in displacement. Displacement whether forced or self imposed in many ways it is a disaster and it is certain. In all cases the term Diaspora carries a sense of displacement and the population so displaced finds itself separated from its national territory. And usually its people have a hope or at least a desire, to return to their home land at some point, if the home land still exists in any meaningful sense.

Exile may be termed as the state of being barred from one's native country and exile is the foremost aspect of getting nostalgic. Exile generally is a painful banishment from one's homeland. Though it can be voluntary or involuntary, internal or external, "exile" generally implies a sort of trauma, an imminent danger, usually political, that makes the home no longer safely habitable. The word 'exile' includes a range of displaced existence.

The Indian Diaspora Writing is a part of exile literature. There

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is a natural exile state in all dislocated lives whether it is intentional or regular migration. Over time remotely separated communities tend to vary in culture, traditions, language and other factors. These writings in displaced circumstances are often termed as Exile Literature. World literature has an abundance of writers whose writings have prospered while they were in exile. Edward W. Said aptly reflecting to the condition of Exile and said,

> "I think that if one is an intellectual one has to exile oneself from what has been given to you, what is customary, and to see it as if it were something that is provisional and foreign to one self. That allows for independence - commitment – but independence and a certain kind of detachment. (Said, Edward p. 13).

The world in existentialist terms appears absurd and indifferent towards one's needs. In such a situation one cannot help but feel like an outsider. Hence it is an admitted fact that exile is a part of human experience. The effects that exile have, not on the writers' works, but on the writers themselves, seem actually paradoxical. Exile appears as both a liberating experience and a shocking experience as well. The paradox is clear because it is just a manifestation of the tension that keeps the strings attached and in flexible between the writer's native place and the place of exile.

Whatever may be the geographical location of the exile writer, in the mental landscape, the writer is forever enmeshed among the strings attached to the place that pulls him in opposite directions. The only way the writer can free himself from the tightness of the enmeshing strings, is by writing or making any other form of artistic expressions. Even if a writer consciously tries to justify one end simultaneously, unconsciously, there arises a longing for the other. There lies the fascination of exile literature.

> "Being in a foreign country means walking a tight rope high above the ground without the net afforded to a person by the country where he has his family, colleagues and friends, and where he can easily say what he has to say in a language he has known from childhood". (Kundera 75)

Moreover, the diaspora writers are constantly adapting

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themselves to the dynamics of their new homes in a positive way as it ought to be. Hence Bharat Gupt specifically with respect to the Indian Diaspora suggest that the Indiaspora needs to be convinced that inorder to survive as independent people in the adopted lands they need to grow with their heritage, not just merely cling to it".(Indian Diaspora http://www.indolink.com).

It is Rushdie who gives us a clear idea of the experience of the immigrant:

> All migrants leave their past behind, although some try to pack it into bundles and boxes-but on the journey something seeps out of the treasured mementoes and old photographs, until even their owners fail to recognize them, because it is the fate of the migrants to be stripped of history, to stand naked amidst the scorn of strangers upon whom they see the rich clothing, the brocades of continuity and the eyebrows of belonging. (S.Rushdie-63).

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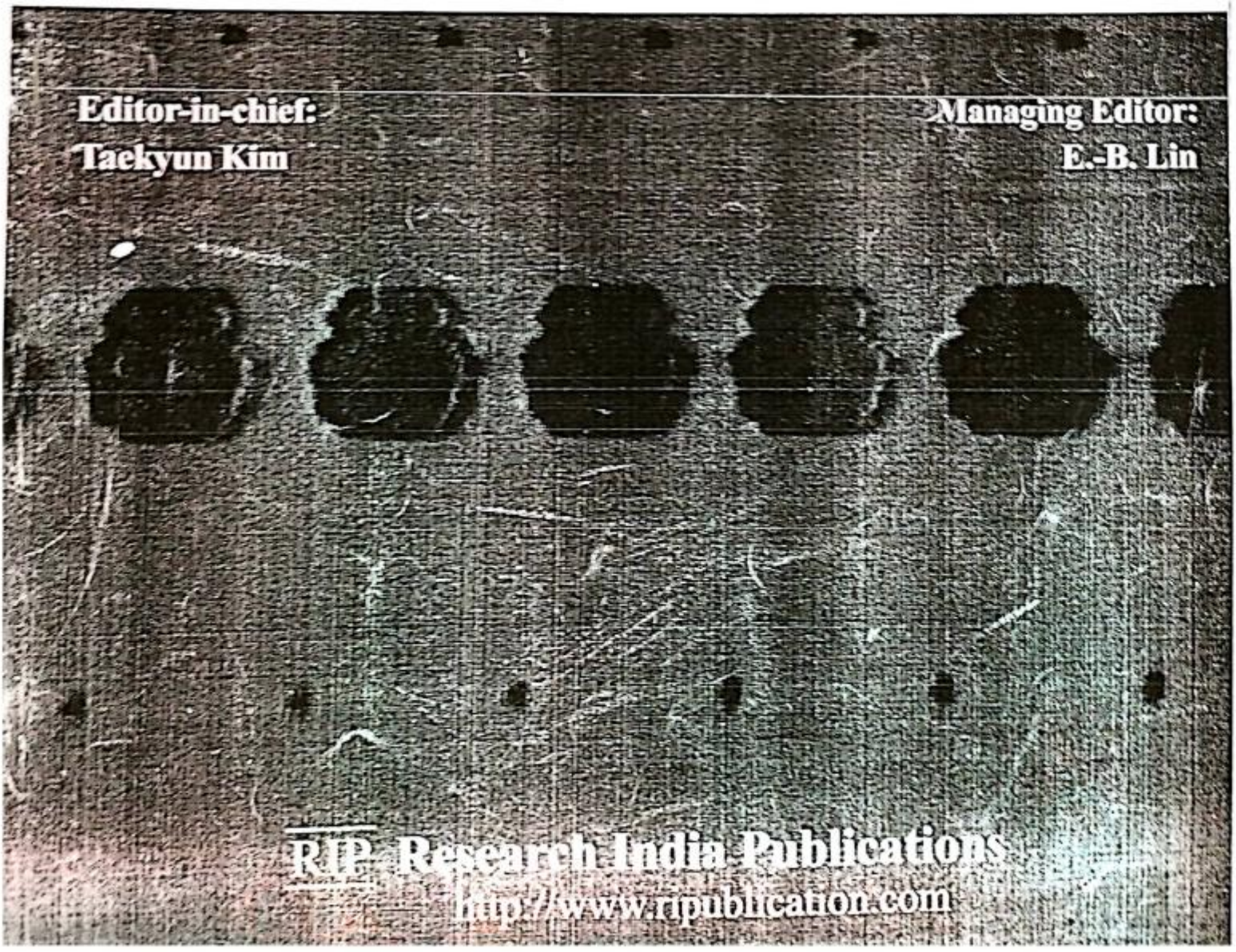

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Effect of Radiation and Heat Sources on Hydromagnetic Convective Heat Transfer Flow in A rotating Vertical Channel Partially Filled with Porous Medium

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Abstract:

We analyse the effect of radiation on unsteady convective MHD flow of a rotating viscous electrically conducting fluid in a vertical channel partially filled by a porous medium in the presence of heat sources. The two infinite vertical porous plates of the channels are subjected to a constant injection velocity at the one plate and the same constant suction velocity at the other plate. The entire system rotates about the axis normal to the plates with a uniform angular velocity. The effect of radiation-conduction parameter (Stark number), Prandtl number, Grashof number, Rotation parameter, Hartmann Number, and Darcy parameter on the velocity field, temperature field and Nusselt number have been discussed in the analysis.

Keywords: Natural convection, radiation, MHD, rotating, Porous medium and Heat sources.

1. INTRODUCTION:

Channels are frequently used in various applications in designing ventilating and heating of buildings, cooling electronic components, drying several types of agriculture products grain and food, and packed bed thermal storage. Convective flows in channels driven by temperature differences of bounding walls have been studied and reported, extensiely in literature. Free convection flows in vertical slots were discussed by Aung et al., [14], Burch et al., [12], Kim et al. [11], Buhler [7], Weidman [8], Magyari [5], Weidman and Medina [9].

Radiative convective flows are frequently encountered in many scientific and environmental processes, such as astrophysical flows, water evaporation from open reservoirs, heating and cooling of chambers,and solar power technology. Several researchers have investigated radiative effects on heat transfer in non porous and porous medium utilizing the Rosseland or other radiative flux model, such as Raptis [1] , Hall et.al. [3], Hakiem [4], Raptis [2].

Magnetohydrodynamics deals with dynamics of an electrically conducting fluid, which interacts with a magnetic field. The study of heat transfer and flow, through and across porous media, is of great theoretical interest because it has been applied to a variety of geophysical and astrophysical phenomena. Practical interest of such study includes applications in electromagnetic lubrication, boundary cooling, bio-physical systems and in many branches of engineering and science. Extensive research in this discipline has been reported such as Yih [6], Kandasamy et al. [10], Prasad et al. [13], Bian et al [15].

Recently Singh et al [16] hence studied hydomagnetic heat transfer flow in a vertical porous chemical with radiation effect.

In this paper we analyse the effect of heat sources and ration on mixed convective heat transfer flow in a vertical porous medium dimensional. The objective is to investigate the effects of heat source radiation, magnetic field, permeability of the porous substrate and injection-suction on the unsteady free convective MHD flow in vertical channel partially filled with a porous substrate when the entire system rotates about an axis normal to the channel plates. The Rosseland radiation flux model is employed which gives good simulating results for optically thick fluids which are absorbing, emitting, gray but not scattering.

2. FORMULATION OF THE PROBLEM:

We analyze the unsteady MHD free convective flow in a vertical channel bounded by porous plate partially filled with a porous material and partially with a clear electrically conducting fluid in the presence of heat sources. The entire system rotates about the axis normal to the plates with uniform angular velocity Ω. The channel is of width 'd' and the thickness of the porous medium is 'h'. A cartesian coordinate system is assumed and z-axis is taken normal to the plates while x and y axes, respectively are in the upward and perpendicular directions on the plate $z = 0$. Two vertical plates are situated at $z = 0$ and $z = d$. The origin is taken at the

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plate. z = 0 and the channel is oriented vertically upward along x-axis. Plates are infinite in extent in x and y directions. These plates are subjected to a constant injection velocity (w_0) at one plate (z = 0) and the some constant suction velocity (w_0) at the other plate (z = d). A uniform magnetic field B_0 is applied along an axis normal to the plates (z – axis) and the entire system rotates about this axis. It is assumed that the magnetic Reynolds number is very small, so that induced magnetic field in neglected [cowling (1957)].

We denote the velocity components $\overline{u}, \overline{v}, \overline{w}$ in porous medium region, and u', v', w' in clear fluid region, in the x, y, z directions respectively. $\overline{T}$ denotes temperature in the porous region, T' denotes temperature in the clear fluid region, and t' denotes time. Since the channel plates are infinite in extent, velocity and temperature components depend only on z' and t', and further, the continuously equation gives $\overline{w} = w' = w_0$ (constant).

Using Rosseland approximation, the radiative heat transfer takes the form following Siegel and Howell (1972), respectively in clear fluid and porous region as follows:

$$q_r = -\frac{4\sigma^*}{3k^*}\frac{\partial T'^4}{\partial z'}; \overline{q}_r = -\frac{4\sigma^*}{3k^*}\frac{\partial \overline{T}^4}{\partial z'} \tag{1}$$

where, σ* is Stefan – Boltzmann constant and k* is mean absorption coefficient for thermal radiation.

Following Raptis (1998) the temperature functions in (1) can be expressed as a linear function of temperature expanding T'^4 *and* $\overline{T}^4$ in a Taylor series about T_d (constant temperature of the right wall) and neglecting higher-order terms, we obtain

$$T'^4 = 4T_d^3T' - 3T_d^4, \text{ and } \overline{T}^4 = 4T_d^3\overline{T} - 3T_d^4 \tag{2}$$

By introducing proper non-dimensional variables.

The dimensionless Governing equations in the porous medium region – I ($0 \le \eta \le \alpha$) and the clear fluid region – II ($\alpha \le \eta \le 1$) for the MHD convective flow of a radiative fluid in the rotating system are respectively given by

For porous region – I

$$\frac{\partial U}{\partial t} + \lambda\frac{\partial U}{\partial \eta} - 2\mathrm{Re}V = \frac{\partial^2 U}{\partial \eta^2} + G_r(\theta - 1) - \frac{U}{K} - M^2U \tag{3}$$

$$\frac{\partial V}{\partial t} + \lambda\frac{\partial V}{\partial \eta} + 2\mathrm{Re}U = \frac{\partial^2 V}{\partial \eta^2} - \frac{V}{K} - M^2V \tag{4}$$

$$\frac{\partial \theta}{\partial t} + \lambda\frac{\partial \theta}{\partial \eta} = \left(\frac{3N+4}{3NP_r}\right)\frac{\partial^2 \theta}{\partial \eta^2} + \alpha \tag{5}$$

For clear fluid region – II

$$\frac{\partial u}{\partial t} + \lambda\frac{\partial u}{\partial \eta} - 2\mathrm{Re}v = \frac{\partial^2 u}{\partial \eta^2} + G_r(T-1) - \frac{U}{K} - M^2u \tag{6}$$

$$\frac{\partial v}{\partial t} + \lambda\frac{\partial v}{\partial \eta} + 2\mathrm{Re}u = \frac{\partial^2 v}{\partial \eta^2} - M^2v \tag{7}$$

$$\frac{\partial T}{\partial t} + \lambda\frac{\partial T}{\partial \eta} = \left(\frac{3N+4}{3NP_r}\right)\frac{\partial^2 T}{\partial \eta^2} + \alpha \tag{8}$$

Where, $\mathrm{Re} = \frac{\Omega d^2}{\gamma}$, $P_r = \frac{\mu C_p}{K}$, $N = \frac{kk^*}{4\sigma^* T_d^3}$,

$$M^2 = \frac{\sigma}{\mu}B_0^2d^2, \quad G_r = \frac{g\beta(T_0 - T_d)d^2}{\gamma w_0}.$$

The corresponding boundary conditions in non-dimensional form are given by

$$\left.\begin{array}{ll} \text{at } \eta = 0, & U = V = 0, \quad \theta = 1 + \epsilon e^{nt} \\ \text{at } \eta = h, & U = u, \quad V = v, \quad \theta = T \\ & \frac{\partial U}{\partial \eta} = \frac{\partial u}{\partial \eta}, \frac{\partial V}{\partial \eta} = \frac{\partial v}{\partial \eta}, \frac{\partial \theta}{\partial \eta} = \frac{\partial T}{\partial \eta} \\ \text{at } \eta = 1, & u = v = 0, \quad T = 0 \end{array}\right\} \tag{9}$$

Here, $\epsilon << 1$ (a positive constant), and n is a dimensionless scalar constant.

3. METHOD OF SOLUTION

We first solve equations (5) and (8) for temperature distribution in porous and clear fluid region. Let us assume

$$\theta(\eta, t) = \theta_0(\eta) + \epsilon\theta_1(\eta)e^{nt} \tag{10}$$

$$T(\eta, t) = T_0(\eta) + \epsilon T_1(\eta)e^{nt} \tag{11}$$

Substituting (10) and (11) in equations (5) and (8) and the corresponding boundary conditions for the temperature distribution, and comparing the coefficients of e^{nt}, we obtain

$$\frac{\partial^2 \theta_0}{\partial \eta^2} - \left(\frac{3\lambda N\,\mathrm{Pr}}{N+4}\right)\frac{\partial \theta_0}{\partial \eta} = -\alpha_1, \quad \theta_0'' - \lambda P_1\theta_0' = -\alpha_1 \tag{12}$$

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$$\frac{\partial^2\theta_1}{\partial\eta^2}-\left(\frac{3\lambda NP_r}{3N+4}\right)\frac{\partial\theta_1}{\partial\eta}-\left(\frac{3nNP_r}{3N+4}\right)\theta_1=0$$

$$\theta_1''-\lambda P_1\theta_1'-P_2\theta_1=0 \qquad (13)$$

$$\frac{\partial^2 T_0}{\partial\eta^2}-\frac{\partial T_0}{\partial\eta}=-\alpha_1 \Rightarrow T_0''-\lambda P_1 T_0'=-\alpha \qquad (14)$$

$$\frac{\partial^2 T_1}{\partial\eta^2}-\left(\frac{3\lambda NP_r}{3N+4}\right)\frac{\partial T_1}{\partial\eta}-\left(\frac{3nNP_r}{3N+4}\right)T_1=0$$

$$T_1''-\lambda P_1 T_1'-P_2 T_1=0 \qquad (15)$$

the corresponding boundary conditions;

$$\eta=0, \quad \theta_0=1 \quad \theta_1=1$$

$$\eta=\alpha, \theta_0=T_0, \ \theta_1=T_1, \quad \frac{\partial\theta_0}{\partial\eta}=\frac{\partial T_0}{\partial\eta}$$

$$\frac{\partial\theta_1}{\partial\eta}=\frac{\partial T_1}{\partial\eta}$$

$$\eta=1, \quad T_0=0, \quad T_1=0 \qquad (16)$$

where $P_1=\frac{3N_0P_r}{3N_0+4}$, $P_2=\frac{3nN\,P_r}{3N\,+4}=nP_1$

On solving (12) – (16) we obtain

$$\left.\begin{aligned}\theta_0&=a_1+a_2e^{P_1\eta}+\frac{\alpha_1}{P_1}\eta\\ T_0&=a_3+a_4e^{P_1\eta}+\frac{\alpha_1}{P_1}\eta\end{aligned}\right\} \qquad (17)$$

$$\left.\begin{aligned}\theta_1&=a_5e^{m_1\eta}+a_6e^{m_2\eta}\\ T_1&=a_7e^{m_1\eta}+a_8e^{m_2\eta}\end{aligned}\right\} \qquad (18)$$

$$a_1=a_3=\frac{P_1e^{P_1}+\alpha_1}{P_1(e^{P_1}-1)},$$

$$a_2=a_4=\frac{P_1+\alpha_1}{P_1(1-e^{P_1})}$$

$$(m_1,m_2)=\frac{\lambda P_1\pm\sqrt{(\lambda P_1)+4P_2}}{2}$$

$$a_5=a_7=\frac{-e^{m_2}}{e^{m_1}-e^{m_2}}$$

$$a_6=a_8=\frac{e^{m_1}}{e^{m_1}-e^{m_2}}$$

The non dimensional rate of heat transfer (Nusselt number) at $\eta=0$ is given by

$$N_{U0}=\left(\frac{\partial\theta}{\partial\eta}\right)_{\eta=0}=P_1a_2+\frac{\alpha_1}{P_1}+\in e^{mt}[m_1a_5+m_2a_6] \qquad (19)$$

The non-dimensional rate of heat transfer (Nusselt number) at $\eta=1$ is given by

$$N_{U1}=\left(\frac{\partial T}{\partial\eta}\right)_{\eta=1}=P_1a_4e^{P_1}+\frac{\alpha_1}{P_1}+\in e^{mt}[m_1a_7e^{m_1}+m_2a_8e^{m_2}] \qquad (20)$$

Velocity distribution

Let $\bar{F}=U+iV$, and $F=u+iv$ (21)

Using above, and the boundary conditions equation (3-di) and (6-7i) reduce to

$$\frac{\partial\bar{F}}{\partial t}+\lambda\frac{\partial\bar{F}}{\partial\eta}+2i\,\mathrm{Re}\,\bar{F}=\frac{\partial^2\bar{F}}{\partial\eta^2}+G_r(\theta-1)-(D^{-1}+M^2)\bar{F} \qquad (22)$$

$$\frac{\partial F}{\partial t}+\lambda\frac{\partial F}{\partial\eta}+2i\,\mathrm{Re}\,F=\frac{\partial^2 F}{\partial\eta^2}+G_r(T-1)-M^2F \qquad (23)$$

and the corresponding boundary conditions are given by

$$\left.\begin{aligned}&\text{at} \quad \eta=0; \quad \bar{F}=0\\ &\text{at} \quad \eta=\alpha; \quad \bar{F}=F, \quad \frac{\partial\bar{F}}{\partial\eta}=\frac{\partial F}{\partial\eta},\\ &\text{at} \quad \eta=1 \quad F=0\end{aligned}\right\} \qquad (24)$$

now, let us assume that

$$U(\eta,t)=U_0(\eta)+\in U_1(\eta)e^{mt}$$

$$V(\eta,t)=V_0(\eta)+\in V_1(\eta)e^{mt}$$

$$u(\eta,t)=u_0(\eta)+\in u_1(\eta)e^{mt}$$

$$v(\eta,t)=v_0(\eta)+\in v_1(\eta)e^{mt}$$

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so that $\bar{F}(\eta, t) = U_0(\eta) + iV_0(\eta) + \epsilon[U_1(\eta) + iV_1(\eta)]e^{mt}$

$= \bar{F}_0(\eta) + \epsilon\ F_1(\eta)e^{mt}$

$F(\eta, t) = u_0(\eta) + iv_0(\eta) + \epsilon[u_1(\eta) + iv_1(\eta)]e^{mt}$

$= F_0(\eta) + \epsilon\ \bar{F}_1(\eta)e^{mt}$ (25)

Substituting (25) in (22-24) and comparing the coefficients of e^{mt}, we obtain

$$\frac{\partial^2 \bar{F}_1}{\partial \eta^2} - \lambda \frac{\partial \bar{F}_0}{\partial \eta} - (D^{-1} + 2i\,\mathrm{Re}) + \bar{F}_0 = G_r(1-\theta_0)$$

$$\frac{\partial^2 \bar{F}_1}{\partial \eta^2} - \lambda \frac{\partial \bar{F}_0}{\partial \eta} - \lambda_2^2 \bar{F}_0 = G_r(1-\theta_0) \quad (26)$$

$$\frac{\partial^2 \bar{F}_1}{\partial \eta^2} - \lambda \frac{\partial \bar{F}_1}{\partial \eta} - (D^{-1} + n + 2i\,\mathrm{Re}) + \bar{F}_1 = -G_r\theta_1$$

$$\frac{\partial^2 \bar{F}_1}{\partial \eta^2} - \lambda \frac{\partial \bar{F}_1}{\partial \eta} - \lambda_4^2 \bar{F}_1 = -G_r\theta_1 \quad (27)$$

$$\frac{\partial^2 F_0}{\partial \eta^2} - \lambda \frac{\partial F_0}{\partial \eta} - (M_1^2 + 2i\,\mathrm{Re})F_0 = G_r(1-T_0)$$

$$\frac{\partial^2 F_0}{\partial \eta^2} - \lambda \frac{\partial F_0}{\partial \eta} - \lambda_1^2 F_0 = G_r(1-T_0) \quad (28)$$

$$\frac{\partial^2 F_1}{\partial \eta^2} - \lambda \frac{\partial F_1}{\partial \eta} - (M^2 + n + 2i\,\mathrm{Re})F_1 = -G_rT_1$$

$$\frac{\partial^2 F_1}{\partial \eta^2} - \lambda \frac{\partial F_1}{\partial \eta} - \lambda_3^2 F_1 = -G_rT_1 \quad (29)$$

and the corresponding boundary conditions;

at $\eta = 0$; $\bar{F}_0 = 0$, $\bar{F}_1 = 0$

at $\eta = \alpha$ $\bar{F}_0 = F_0$, $\bar{F}_1 = F_1$, (30)

$$\frac{\partial \bar{F}_0}{\partial \eta} = \frac{\partial F_0}{\partial \eta}, \frac{\partial \bar{F}_1}{\partial \eta} = \frac{\partial F_1}{\partial \eta}$$

at $\eta = 1$; $F_0 = 0$, $F_1 = 0$.

Where $\lambda_1^2 = M^2 + 2i\,\mathrm{Re}$

$\lambda_3^2 = M^2 + \eta + 2i\,\mathrm{Re}$

$\lambda_2^2 = D^{-1} + 2i\,\mathrm{Re}$

$\lambda_4^2 = D^{-1} + n + 2i\,\mathrm{Re}$

On solving (26) - (29), we get

$$\bar{F}_0 = a_{18}e^{m_1\eta} + a_{19}e^{m_2\eta} + a_{15} + a_{16}\eta - a_{17}e^{m_3\eta} \quad (31)$$

$$\bar{F}_1 = a_{31}e^{m_5\eta} + a_{32}e^{m_6\eta} + a_{29}e^{m_4\eta} + a_{30}e^{m_7\eta} \quad (32)$$

$$F_0 = a_{12}e^{m_3\eta} + a_{13}e^{m_4\eta} + a_9 + a_{10}\eta + a_{11}e^{m_1\eta} \quad (33)$$

$$F_1 = a_{27}e^{m_7\eta} + a_{28}e^{m_8\eta} + a_{25}e^{m_5\eta} + a_{26}e^{m_6\eta} \quad (34)$$

Where $a_9 - a_{32}$ are constants.

4. DISCUSSION:

In this analysis we investigate the effect of heat sources on the convective heat transfer in a vertical channel with a porous be attached to the left vertical plate. We analyze effect of G, D^{-1}, α, M, N_1, λ on the buoyancy induced flow in rotating vertical channel is investigated. The results are presented graphically and discuss this problem has several practical applications such has metallurgy where the process of solidification is characterized by the presence of a liquid, a mushy zone and a solid zone; in geothermal systems; cooling of electronic components; and in many fluid engineering applications.

1. We observe that because of the temperature gradient in the system, the fluid near the left wall (hot wall) rises in the attached porous substrate and in the near by region of the fluid-porous interface, and near the cold wall it descends. The motion of the fluid in the x –direction is a result of the buoyant force term in the momentum equation. In fig 1 we observe that this rise and fall of the fluid in the channel is further enhanced by the increase in the thermal Grashof number Gr (fig.1).

2. The effect of thermal radiation N_1 which is defined as relative contribution of the conduction heat transfer to the thermal radiation transfer. Thus with smaller N_1 values, the thermal radiation is larger than the thermal conduction. It is found the (fig 4) that by increasing N_1 the primary velocity enhances with $N_1 \leq 3.5$ and reduces with higher $N_1 \geq 5$ near the left wall in the porous medium and the remaining region it reduces with N. An increase in the parameter N reduces the primary velocity both in the porous bed and the clean fluid (fig.2)

3. The heat source parameter α it is found that increase the strength of heat source accelerate the primary velocity both in the porous bed and clean fluid while an increasing strength of the heat sink depreciate the primary velocity the porous bed and accelerate in the clean fluid (fig.3).

4. The effect of section parameter λ is found that for smaller and higher values of λ the primary flow is positive and for intermediate values it is negative in the

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porous bed while in the clean fluid it is negative |u| depreciate $\lambda \leq 2$ and enhances with higher $\lambda \geq 5$. While in the clean fluid the primary flow enhances with $\lambda \leq 1.5$ and depreciate with higher $\lambda \geq 2$ .we notice that |u| experiences an enhancement both in the porous bed and clean fluid (fig.4).

The influence of the radiation parameter N_1 on the secondary flow shows that an increasing $N_1 \leq 3.5$ and enhances |v| and depreciate with higher $N_1 \geq 5$ in the porous bed and its nearby region. While remaining region the secondary flow accelerate in the negative direction with increases in N_1(fig.6).

the increase $\alpha > 0$ depreciates the secondary flow while it enhances with $|\alpha|$ in the porous bed and nearby region while in the remaining region the secondary flow accelerate with increase in the $\alpha > 0$ and depreciate $|\alpha|$ (fig.7).

7. an increase section parameter $\lambda \leq 2$ accelerate secondary flow and depreciate with higher $\lambda \geq 5$ in the entire flow region (fig.8)
8. it is found that the lesser the thermal radiation flux larger temperature flux in fluid region (fig.9). The variation 0 the heat source parameter α shows that the temperature enhances with increasing strength of heat source and depreciate with strength of heat sink(fig.10). We find that the temperature accelerates with increase in the section parameter λ (fig.11).

It is found that the rate of heat transfer of hot wall $\eta = 0$ depreciate with $\alpha > 0$ and enhances with $\alpha < 0$ also $|Nu_0|$ experiences depreciate with increase the radiation parameter N_1 and Prandtl number P. While at cold wall $\eta = 1$ the rate of heat transfer accelerate with $\alpha > 0$ and depreciate of $\alpha < 0$ and enhances with increase N_1 or P.(table1–4)

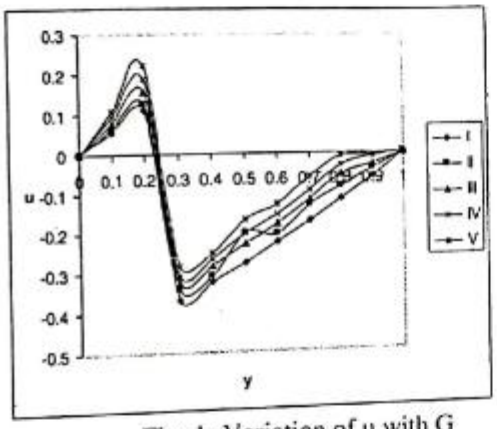

Fig. 1: Variation of u with G

	I	II	III	IV	V
G	0.5	1	2	3	4

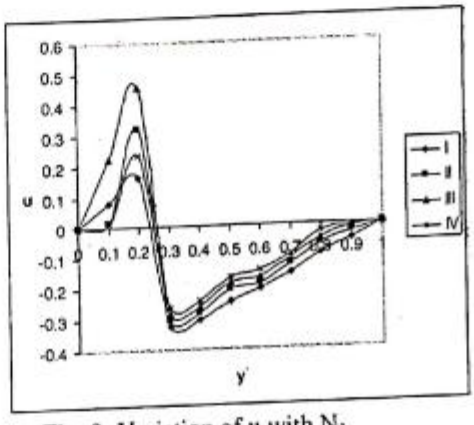

Fig. 2: Variation of u with N_1

	I	II	III	IV	V
N_1	0.5	1.5	2.5	3.5	5

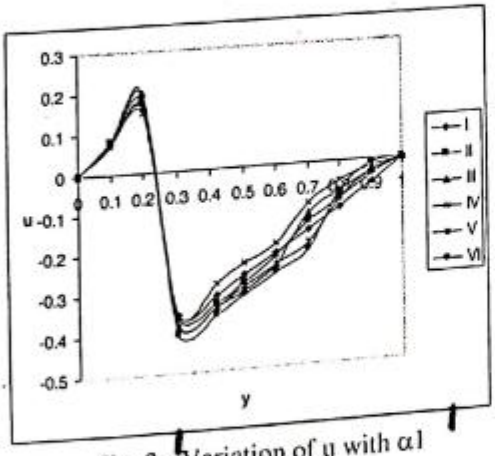

Fig. 3 : Variation of u with $\alpha 1$

	I	II	III	IV	V	VI
$\alpha 1$	0.2	0.4	0.6	-0.2	-0.4	-0.6

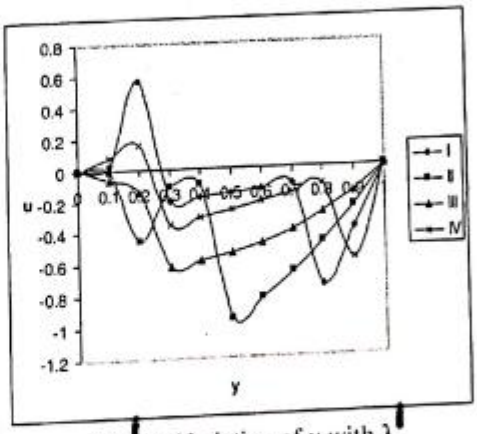

Fig. 4 : Variation of v with λ

	I	II	III	IV
λ	1	1.5	2	5

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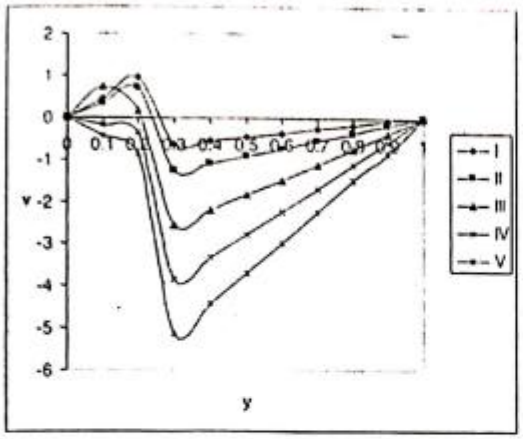

Fig. 5 : Variation of v with G

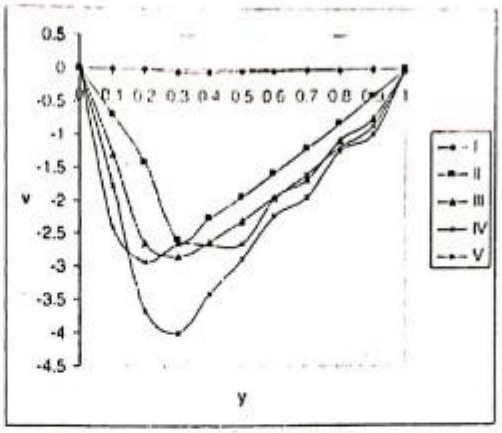

Fig. 6 : Variation of v with N1

	I	II	III	IV	V
G	0.5	1	2	3	4

	I	II	III	IV	V
N1	0.5	1.5	2.5	3.5	5

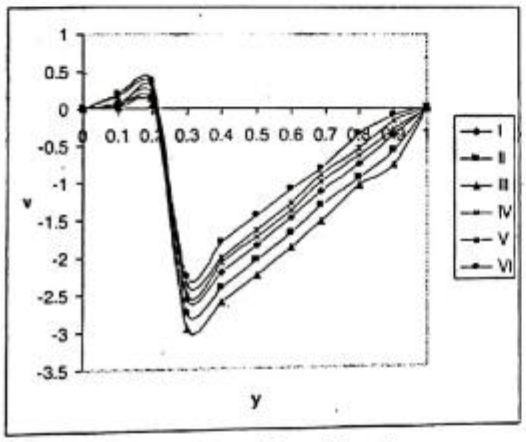

Fig. 7 : Variation of v with α1

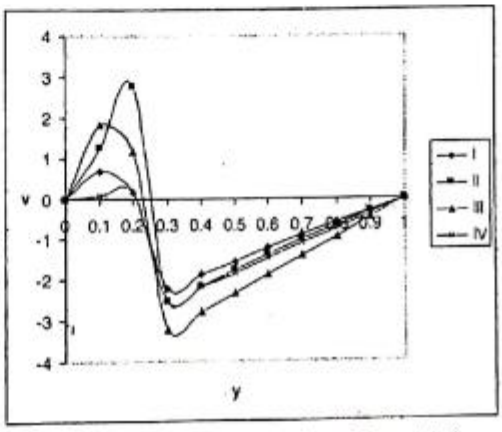

Fig. 8 : Variation of v with λ

	I	II	III	IV	V	VI
α1	0.2	0.4	0.6	-0.2	-0.4	-0.6

	I	II	III	IV
λ	1	1.5	2	5

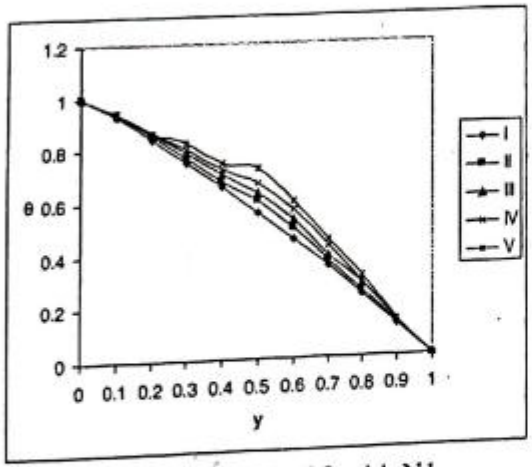

Fig. 9: Variation of θ with N1

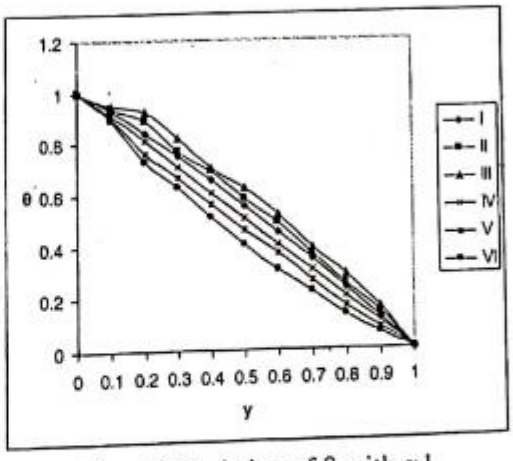

Fig. 10: Variation of θ with α1

	I	II	III	IV	V
N1	0.5	1.5	2.5	3.5	5

	I	II	III	IV	V	VI
α1	0.4	0.4	0.6	-0.2	-0.4	-0.6

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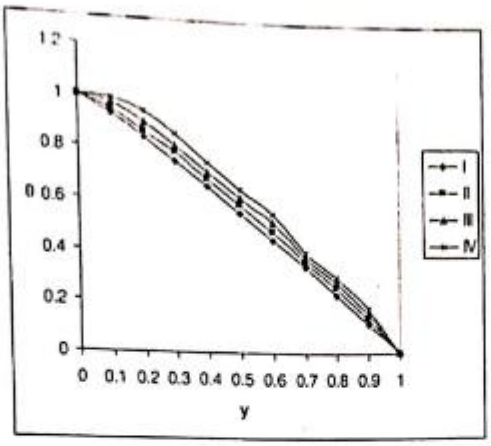

Fig. 11: Variation of θ with λ

	I	II	III	IV
λ	1	1.5	2	0.5

Table – 1

Nu_0

α	I	II	III	IV	V
0.2	-0.89896	-0.79235	-0.74385	-0.71617	-0.69150
0.4	-0.87257	-0.74272	-0.68365	-0.64993	-0.61989
-0.2	-0.95174	-0.89162	-0.86426	-0.84864	-0.83472
-0.4	-0.97814	-0.94125	-0.92446	-0.91487	-0.90633
N_1.	0.5	1.5	2.5	3.5	5

Table – 2

Nu_0

α	I	II	III	IV
0.2	-0.89896	-0.89896	-0.89896	-0.89896
0.4	-0.87257	-0.87257	-0.87257	-0.87257
-0.2	-0.95174	-0.95174	-0.95174	-0.95174
-0.4	-0.97814	-0.97814	-0.97814	-0.97814
P	0.1	7	10	30

Table – 3

Nu_1

α	I	II	III	IV	V
0.2	-1.14908	-1.27788	-1.34196	-1.38027	-1.41553
0.4	-1.17723	-1.33413	-1.41220	-1.45886	-150181
-0.2	-1.09277	-1.16538	-1.20150	-1.22309	-1.24296
-0.4	-1.06462	-1.10913	-1.13126	-1.14450	-1.15667
N_1	0.5	1.5	2.5	3.5	5

Table – 4

Nu_1

α	I	II	III	IV
0.2	-1.14908	-1.14908	-1.14908	-1.14908
0.4	-1.17723	-1.17723	-1.17723	-1.17723
-0.2	-1.09277	-1.09277	-1.09277	-1.09277
-0.4	-1.06462	-1.06462	-1.06462	-1.06462
P	0.1	7	10	30

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Radiation Effect On Unsteady Mhd Convective Heat Mass Flow Of A Viscous Fluid Through A Porous Medium In A Vertical Channel With Oscillatory Wall Temperatures And Quadratic Density - Temperature Variation

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ABSTRACT:

We investigate the study make an attempt to analyse the effect of radiation unsteady convective heat transfer of a dissipative viscous fluid through a porous medium confined in a vertical channel on whose walls an oscillatory temperature is prescribed with quadratic density-temperature variation. Approximate solutions to coupled non-linear partial differential equations governing the flow and heat transfer are solved by a perturbation technique. The velocity, temperature,skin friction and rate of heat transfer are discussed for different variations of G, D^{-1}, α, Ec, P, N and t.

Keywords : Viscous fluid, Porous medium, vertical channel, oscillatory wall temperature, quadratic density.

1. INTRODUCTION

Free convection flows between two long vertical plates have been studied for many years because of their engineering applications in the fields of nuclear reactors, heat exchangers, cooling appliances in electronic instruments. These flow were studied by assuming the plates at two different constant temperatures or temperature of the plates varying linearly along the plates etc. The study of fully developed free convection flow between two parallel plates at constant temperature was initiated by Ostrach (19). Combined natural and forced convection laminar flow with linear wall temperature profile was also studied by Ostrach (20).

Transient free convection flow between two long vertical parallel plates maintained at constant but unequal temperatures was studied by Singh *et al* (28). Jha *et al* (10) extended the problem to consider symmetric heating of the channel walls. Narahari *et al*. (15) analyzed the transient free convection flow between two long vertical parallel plates with constant heat flux at one boundary, the other being maintained at a constant temperature. Singh and Paul (28) presented and analysis of the transient free convective flow of a viscous incompressible fluid between two parallel vertical walls occurring as a result of asymmetric heating / coolong of the walls. Narahari (16)

In the context of space technology and in processes involving high temperatures, the effects of radiation are of vital importance. Recent developments in hypersonic flights, missile reentry, rocket combustion chambers, power plants for inter planetary flight and gas-cooled nuclear reactors have focused attention on thermal radiation as a mode of energy transfer and emphasize the need for improved understanding of radiative transfer in these processes. several authors have studies radiative heat transfer in chemical under vertical condision.

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2. FORMULATION AND SOLUTION OF THE PROBLEM

We consider the non-Darcy unsteady flow of a viscous incompressible fluid through a porous medium in a vertical channel bounded by flat walls in the presence of constant heat sources. The unsteadiness in the flow is due to the oscillatory temperature prescribed on the boundaries. We choose a Cartesian coordinate system $\bar{0}(\bar{x}\ \bar{y})$ with walls at $\bar{y} = \pm 1$ by using Boussinesq approximation we consider the density variation only on the buoyancy term Also the kinematic viscosity υ the thermal conductivity k are treated as constants. The equation governing the flow and heat transfer are

$$\frac{\partial u}{\partial t} = \frac{\mu}{\rho}\frac{\partial^2 u}{\partial y^2} - \left(\frac{\mu}{k}\right)u - \left(\frac{\sigma\mu_e^2 H_o^2}{\rho}\right)u - \rho\bar{g} \qquad (2.1)$$

$$\rho_0 C_p \frac{\partial T}{\partial t} = K_f \frac{\partial^2 T}{\partial y^2} + Q + 2\mu(u_1^2) + \frac{\mu}{k}u^2 - \frac{\partial(q_R)}{\partial y} \qquad (2.2)$$

$$\rho - \rho_0 = -\beta_0(T - T_0) - \beta_1(T - T_0)^2 \qquad (2.3)$$

where u is a velocity component in x-direction, T is a temperature, p is a pressure, ρ is a density ,k is the permeability of the porous medium,μ is dynamic viscosity, k_f is coefficient of thermal conductivity, β is coefficient of volume expansion and Q is the strength of heat source

The boundary conditions are

$$\left.\begin{array}{l} u = 0, \quad T = T_1 \text{ at } y = -L \\ u = 0, T = T_1 + \epsilon(T_2 - T_1)\cos\omega t \end{array}\right\} \qquad (2.4)$$

on introducing the non dimensional variables

$$y' = y/L, \qquad u' = \frac{u}{(\nu/L)} \qquad \theta = \frac{T - T_1}{T_2 - T_1}, \qquad t' = \omega t,$$

Equations 2.1 & 2.2 reduce to (dropping the dashes)

$$\gamma_1^2 \frac{\partial u}{\partial t} = G(\theta + \gamma\theta^2) + \frac{\partial^2 u}{\partial y^2} - (D^{-1} + M^2)u \qquad (2.5)$$

$$P\gamma_1^2 \frac{\partial \theta}{\partial t} = \left(1 + \frac{4}{3N}\right)\frac{\partial^2 \theta}{\partial y^2} + \alpha + PE_c u_y^2 + P E_c D^{-1} u^2 \qquad (2.6)$$

where

$$G = \frac{\beta g L^3 (T_2 - T_1)}{\gamma^2} \qquad \text{(Grashof number)}$$

$$D^{-1} = \frac{L^2}{k} \qquad \text{(Darcy parameter)}$$

$$P = \frac{\mu C_p}{K_f} \qquad \text{(Prandtl number)}$$

$$\alpha = \frac{Q L^2}{(T_1 - T_2)K_f} \qquad \text{(Heat source parameter)}$$

$$Ec = \frac{\mu^2}{C_p L^2 (T_2 - T_1)} \qquad \text{(Eckert Number)}$$

$$N = \frac{4\sigma^* T_e^3}{3\beta_R} \qquad \text{(Radiation parameter)}$$

$$\gamma_1^2 = \frac{\omega L^2}{\nu} \qquad \text{(Wormsely Number)}$$

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$$\gamma^2 = \frac{\beta_1(T_2 - T_1)}{\beta_0} \qquad \text{(Density ratio)}$$

$$P_1 = \frac{3NP}{3N+4} \quad \alpha_1 = \frac{3N\alpha}{3N+4}$$

$$M_1^2 = M^2 + D^{-1}$$

The transformed boundary conditions are

$$\left.\begin{array}{l} u = 0, \quad \theta = 0, \quad \text{at } y = -1 \\ u = 0, \quad \theta = 1 + \epsilon \cos(\omega t) \quad \text{at } y = +1 \end{array}\right\} \qquad (2.7)$$

3.METHOD OF SOLUTION

In view of the boundary condtions (2.4) we assume

$$u = u_0 + \epsilon e^{it} u_1 \qquad (2.8)$$
$$\theta = \theta_0 + \epsilon e^{it} \theta_1$$

Substituting the series expansion (2.8) in equations(2.5)&(2.6) and separating the steady and transient terms we get

$$\frac{\partial^2 u_0}{\partial y^2} - M_1^2 u_0 = -G(\theta_0 + \gamma\theta_*^2) \qquad (2.9)$$

$$\frac{\partial^2 u_1}{\partial y^2} - (M_1^2 + i\gamma^2)u_1 = -G(\theta_1 + 2\theta_0\theta_1) \qquad (2.10)$$

$$\frac{\partial^2 \theta_0}{\partial y^2} + \alpha_1 + P_1 E_c \frac{\partial^2 u_0}{\partial y^2} + P_1 E_c D^{-1} u_0^2 = 0 \qquad (2.11)$$

$$\frac{\partial^2 \theta_1}{\partial y^2} - (iP\gamma^2)\theta_1 + (2P_1 Ec)\frac{\partial u_0}{\partial y}.\frac{\partial u_1}{\partial y} + (P_1 Ec D^{-1})u_0 u_1 \qquad (2.12)$$

Since the equations (2.9 – 2.12) are non-linear coupled equations., assuming Ec << 1 we take

$$u_0 = u_{00} + Ec\, u_{01}$$
$$u_1 = u_{10} + Ec\, u_{11}$$
$$\theta_0 = \theta_{00} + Ec\, \theta_{01} \qquad (2.13)$$
$$\theta_1 = \theta_{10} + Ec\, \theta_{11}$$

Substitutimg (2.13) in equations (2.9) – (2.12) and separating the like terms we get

$$u_{00}^{11} - M_1^2 u_{00} = -G(\theta_{00} + \gamma\theta_{00}\theta_{01}), \qquad u_{00}(\pm 1) = 0 \qquad (2.14)$$

$$\theta_{00}^{11} = -\alpha_1, \qquad \theta_{00}(-1) = 0, \theta_{00}(+1) = 1 \qquad (2.15)$$

$$u_{01}^{11} - M_1^2 u_{01} = -G(\theta_{01} + 2\theta_{00}\theta_{01}), u_{01}(\pm 1) = 0 \qquad (2.16)$$

$$\theta_{01}^{11} = -P_1 u_{00}^{12} - P_1 D^{-1} u_{00}^2, \qquad \theta_{01}(-1) = 0 = \theta_{01} \qquad (2.17)$$

$$u_{10}^{11} - (M_1^2 + i\gamma^2)u_{10} = -G(\theta_{10} + 2\gamma\theta_{00}\theta_{10}), u_{10}(\pm 1) = 0 \qquad (2.18)$$

$$\theta_{10}^{11} - iP_1\gamma_1^2\theta_{10} = 0, \qquad \theta_{10}(-1) = 0, \qquad \theta_{10}(+1) = 1 \qquad (2.19)$$

$$u_{11}^{11} - (M_1^2 + i\gamma_1^2)u_{11} = -G\theta_{11}, \quad u_{11}(\pm 1) = 0 \qquad (2.20)$$

$$\theta_{11}^{11} - (iP_1\gamma_1^2)\theta_{11} = -2P_1 u_{00}^1 u_{10}^1 - 2P_1 D^{-1} u_{00} u_{10}, \theta_{11}(\pm 1) = 0 \qquad (2.21)$$

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Solving the equations (2.14)-(2.21) subject to the relevant boundary conditions we obtain

$$\theta_{\infty} = \frac{\alpha_1}{2}(1-y^2)+0.5(y+1)$$

$$u_{00} = a_8(1-\frac{Ch(M_1y)}{Ch(M_1)})+a_{10}(y^2-\frac{Ch(M_1y)}{Ch(M_1)})-a_{12}(y^4-\frac{Ch(M_1y)}{Ch(M_1)})+$$
$$+a_9(y-\frac{Sh(M_1y)}{Sh(M_1)})-a_{11}(y^3-\frac{Sh(M_1y)}{Sh(M_1)})$$

$$\theta_{01} = a_{51}y^2+a_{52}y^3+a_{53}y^4+a_{54}y^5+a_{55}y^6+a_{56}y^7+a_{57}y^8+$$
$$+a_{58}y^9+a_{59}y^{10}+a_{60}Ch(2M_1y)+a_{61}Sh(2M_1y)+$$
$$+(a_{62}+ya_{64}+y^2a_{66}+y^3a_{68}+y^4a_{70})Sh(M_1y)+$$
$$+(a_{63}+ya_{65}+y^2a_{67}+y^3a_{69}+y^4a_{71})Ch(M_1y)+$$
$$+a_{72}y+a_{73}$$

$$u_{01} = b_1(1-\frac{Ch(M_1y)}{Ch(M_1)})+b_2(y-\frac{Sh(M_1y)}{Sh(M_1)})+b_3((y^2-\frac{Ch(M_1y)}{Ch(M_1)})+$$
$$+b_4((y^3-\frac{Sh(M_1y)}{Sh(M_1)})+b_5(y^4-\frac{Ch(M_1y)}{Ch(M_1)})+b_6(y^5-\frac{Sh(M_1y)}{Sh(M_1)})+$$
$$+b_7(y^6-\frac{Ch(M_1y)}{Ch(M_1)})+b_8((y^7-\frac{Sh(M_1y)}{Sh(M_1)})+b_9(y^8-\frac{Ch(M_1y)}{Ch(M_1)})+$$

$$+b_{10}(y^9-\frac{Sh(M_1y)}{Sh(M_1)})+b_{11}(y^{10}-\frac{Ch(M_1y)}{Ch(M_1)})+b_{12}(y^{11}-\frac{Sh(M_1y)}{Sh(M_1)})+$$
$$+b_{13}((y^{12}-\frac{Ch(M_1y)}{Ch(M_1)})+b_{14}(Ch(2M_1y)-Ch(2M_1))+b_{15}(Sh(2M_1y)-$$
$$-ySh(2M_1))+(b_{16}+yb_{18})(ySh(M_1y)-Sh(M_1))+b_{17}y(Ch(M_1y)-$$
$$-Ch(M_1))+(b_{19}+yb_{21})(y^2Ch(M_1y)-Ch(M_1))+b_{20}(y^3Sh(M_1y-$$
$$-Sh(M_1)+b_{22}y(y^3Sh(M_1y)-Sh(M_1))+b_{23}(y^4Ch(M_1y)-Ch(M_1))+$$
$$+b_{24}(y^5Sh(M_1y)-Sh(M_1))+b_{25}y(y^4Ch(M_1y)-Ch(M_1))+$$

$$+b_{26}y(y^5Sh(M_1y)-Sh(M_1))$$

$$\theta_{10} = 0.5(\frac{Ch(\beta_2y)}{Ch(\beta_2)}+\frac{Sh(\beta_2y)}{Sh(\beta_2)})$$

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$$u_{10} = b_{45}Ch(\beta_3 y) + b_{46}Sh(\beta_3 y) + \phi_4(y)$$

$$\phi_4(y) = (b_{39} + yb_{42} + y^2 b_{44})Sh(\beta_2 y) + (b_{40} + yb_{41} + y^2 b_{43})Ch(\beta_2 y)$$

where $a_1, a_2, \ldots\ldots\ldots a_{73}, b_1, \ldots\ldots\ldots b_{43}$ are constants given in the Appendix.

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EFFECT OF QUADRATIC DENSITY TEMPERATURE VARIATION ON CONVECTIVE HEAT TRANSFER FLOW IN VERTICAL CHANNEL

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ABSTRACT:

We investigate the study convective heat transfer flow of a viscous electrically conducting fluid in a vertical wavy channel under the influence of an inclined magnetic fluid with heat generating sources. The walls of the channels are maintained at constant temperature. The equations governing the flow and heat are solved by employing perturbation technique with the slope δ of the wavy wall as a perturbation parameter. The velocity and temperature distributions are investigated for different values of G, M, m, N, N_1, α and x. The rate of heat transfer is numerically evaluated for different variations of the governing parameters.

Keywords : Vertical Wavy Channel, Quadratic Density Temperature Variation, Hall Effects, Radiation

1.INTRODUCTION:

It has been established [9] that channels with diverging – converging geometries augment the transportation of heat transfer and momentum. As the fluid flows through a tortuous path viz., the dilated – constricted geometry, there will be more intimate contact between them. The flow takes place both axially (primary) and transversely (secondary) with the secondary velocity being towards the axis in the fluid bulk rather than confining within a thin layer as in straight channels. Hence it is advantageous to go for converging-diverging geometries for improving the design of heat transfer equipment. Keeping these applications in view several authors (33,31,32,15,8,19,30,10,14,3,11) have studies heat transfer in wavy channel under vertical conditions.

In this paper we investigate the study convective heat transfer flow of a viscous electrically conducting fluid in a vertical wavy channel under the influence of an inclined magnetic fluid with heat generating sources. The walls of the channels are maintained at constant temperature. The equations governing the flow and heat are solved by employing perturbation technique with the slope δ of the wavy wall as a perturbation parameter. The velocity and temperature distributions are investigated for different values of G, M, m, N, N_1, α and x. The rate of heat transfer is numerically evaluated for different variations of the governing parameters.

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2.ANALYSIS OF THE FLOW

Introduce the transformation such that

$\bar{x} = \delta x, \frac{\partial}{\partial x} = \delta \frac{\partial}{\partial \bar{x}}$ Then $\frac{\partial}{\partial x} \approx O(\delta) \rightarrow \frac{\partial}{\partial \bar{x}} \approx O(1)$

Assuming the slope δ of the wavy boundary to be small we take

$$\psi(x,z) = \psi_0(x,y) + \delta\psi_1(x,z) + \delta^2\psi_2(x,z) + \ldots\ldots\ldots\ldots \quad (3.1)$$

$$\theta(x,z) = \theta_0(x,z) + \delta\theta_1(x,z) + \delta^2\theta_2(x,z) + \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

Let $\eta = \frac{x}{f(\bar{z})}$

Substituting (3.1) in equations (2.16)&(2.17) and using (3.2) and equating the like powers of δ the equations and the respective boundary conditions to the zeroth order are

$$\frac{\partial^2\theta_0}{\partial\eta^2} = -(\alpha_1 f^2) \quad (3.3)$$

$$\frac{\partial^4\psi_0}{\partial\eta^4} - \left(M_1^2 f^2\right)\frac{\partial^2\psi_0}{\partial\eta^2} = -\frac{Gf^3}{R}\left(\frac{\partial\theta_0}{\partial\eta} + 2\gamma\theta_0\frac{\partial\theta_0}{\partial\eta}\right) \quad (3.4)$$

with

$$\psi_0(+1) - \psi_0(-1) = 1 \quad (3.5)$$

$$\frac{\partial\psi_0}{\partial\eta} = 0, \quad \frac{\partial\psi_0}{\partial\bar{z}} = 0, \quad \theta_0 = 1 \quad at \quad \eta = -1$$

$$\frac{\partial\psi_0}{\partial\eta} = 0, \quad \frac{\partial\psi_0}{\partial\bar{z}} = 0, \quad \theta_0 = 0 \quad at \quad \eta = +1$$

and to the first order are

$$\frac{\partial^2\theta_1}{\partial\eta^2} = P_1 Rf\left(\frac{\partial\psi_0}{\partial\eta}\frac{\partial\theta_0}{\partial\bar{z}} - \frac{\partial\psi_0}{\partial\bar{z}}\frac{\partial\theta_0}{\partial\eta}\right) \quad (3.6)$$

$$\frac{\partial^4\psi_1}{\partial\eta^4} - \left(M_1^2 f^2\right)\frac{\partial^2\psi_1}{\partial\eta^2} = -\frac{Gf^3}{R}\left(\frac{\partial\theta_1}{\partial\eta} + 2\gamma(\theta_0\frac{\partial\theta_1}{\partial\eta} + \theta_1\frac{\partial\theta_0}{\partial\eta})\right) + Rf\left(\frac{\partial\psi_0}{\partial\eta}\frac{\partial^3\psi_0}{\partial z^3} - \frac{\partial\psi_0}{\partial\bar{z}}\frac{\partial^3\psi_0}{\partial x\partial z^2}\right) \quad (3.7)$$

with

$$\psi_1(+1) - \psi_1(-1) = 0 \quad (3.8)$$

$$\frac{\partial\psi_1}{\partial\eta} = 0, \quad \frac{\partial\psi_1}{\partial\bar{z}} = 0, \quad \theta_1 = 0, \quad at \quad \eta = -1$$

$$\frac{\partial\psi_1}{\partial\eta} = 0, \quad \frac{\partial\psi_1}{\partial\bar{z}} = 0, \quad \theta_1 = 0 \,.at \quad \eta = +1$$

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3. SOLUTIONS OF THE PROBLEM

Solving the equations (3.3), (3.4)&(3.6,(30.) subject to the boundary conditions (3.5).we obtain

$$\theta_0 = 0.5k^2(1-\eta^2)+0.5(1-\eta)$$

$$\psi_0 = a_{19}Ch(\beta_1\eta)+a_{20}Sh(\beta_1\eta)+a_{21}\eta+a_{22}+\phi_1(\eta)$$

$$\phi_1(\eta) = a_{10}\eta^5+a_{11}\eta^4+a_{16}\eta^3+a_{17}\eta^2+a_{18}\eta+a_{15}$$

4. SHEAR STRESS and NUSSELT NUMBER

The stress tensor for the motion on the boundaries is given by

$$\sigma_{ij} = -p\delta_{ij}+2\mu e_{ij}$$

where

$$e_{xx} = \frac{\partial u}{\partial x}, e_{zz} = \frac{\partial v}{\partial z}$$

$$e_{xz} = 0.5\left(\frac{\partial u}{\partial z}+\frac{\partial w}{\partial x}\right)$$

The stress on the walls $\eta = \pm 1$, in the non-dimensional form is given by

$$\tau = (e_{xy}(1-f'^2)+(e_{xx}-e_{yy})f'/(1+f'^2)$$

In terms of non-dimensional variables, we obtain the non-dimensional shear stress is

$$(\tau)_{\eta=+1} = \frac{f^2(1+f'^2)c_{51}+\delta(f^2(1-f'^2)c_{55}.-2(f'/f)c_{53})+O(\delta^2)}{(1+f'^2)}$$

$$(\tau)_{\eta=-1} = \frac{f^2(1+f'^2)c_{52}+\delta(f^2(1-f'^2)c_{56}-2(f'/f)c_{54})+O(\delta^2)}{(1+f'^2)}$$

The rate of heat transfer (Nusselt Number) on the walls has been calculated using the formula

$$Nu = \frac{1}{f(\theta_m-\theta_w)}\left(\frac{\partial\theta}{\partial\eta}\right)_{\eta=\pm1}$$

where

$$\theta_m = 0.5\int_{-1}^{1}\theta\, d\eta$$

$$(Nu)_{\eta=+1} = \frac{1}{f\theta_m}(a_{54}+\delta\ b56)$$

$$(Nu)_{\eta=-1} = \frac{1}{f(\theta_m-1)}(b_{54}+\delta\ b_{55})$$

$$\theta_m = b_{57}+\delta b_{58}$$

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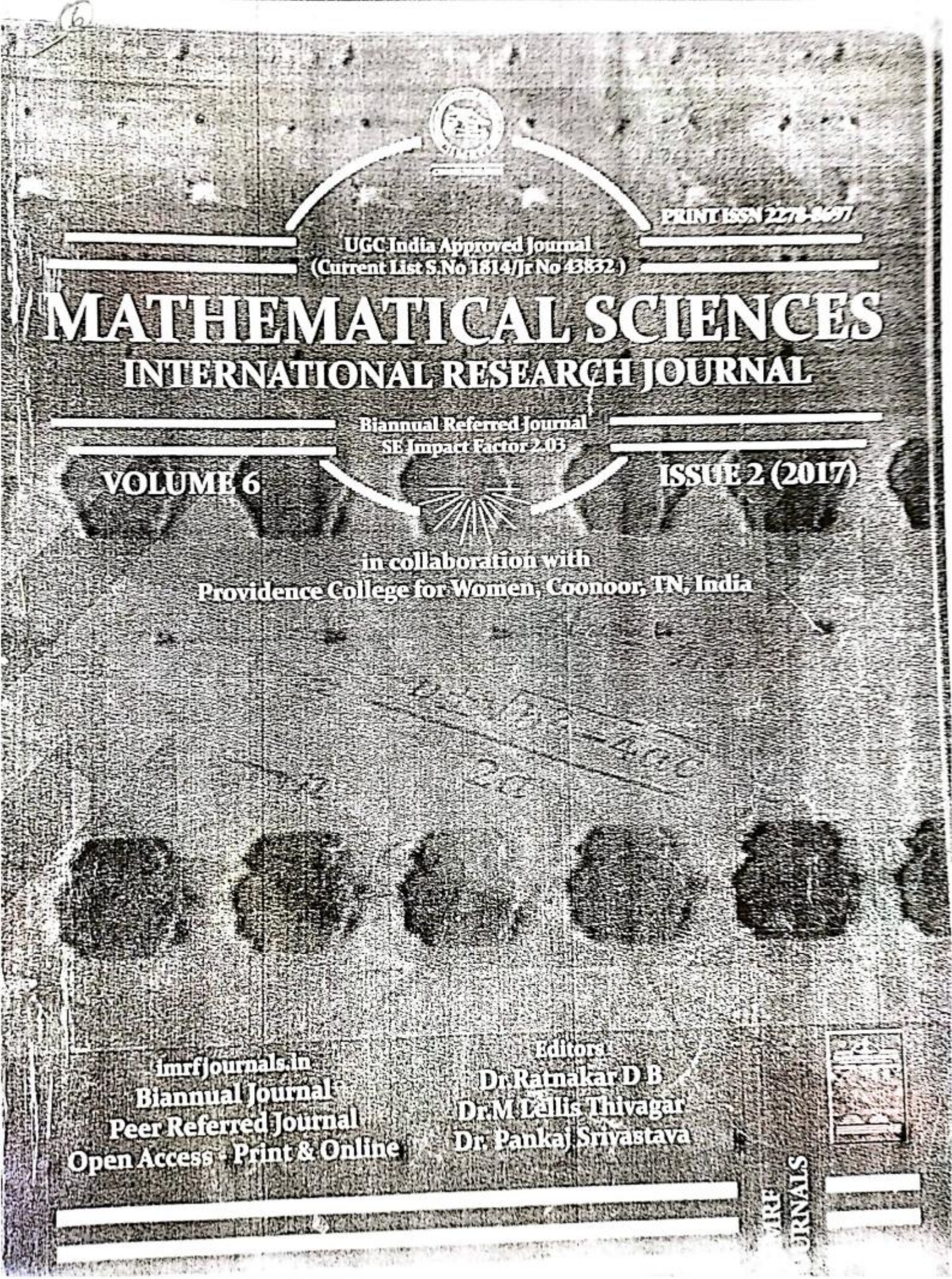

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EFFECT OF QUADRATIC DENSITY TEMPERATURE VARIATION ON CONVECTIVE HEAT TRANSFER FLOW IN VERTICAL CHANNEL

Dr. B.Suseelavathy

Department of Mathematics, S.S. & N College, Narasarao Pet, Guntur District, A.P., India

Abstract: We investigate the study convective heat transfer flow of a viscous electrically conducting fluid in a vertical wavy channel under the influence of an inclined magnetic fluid with heat generating sources. The walls of the channels are maintained at constant temperature. The equations governing the flow and heat are solved by employing perturbation technique with the slope δ of the wavy wall as a perturbation parameter. The velocity and temperature distributions are investigated for different values of G, M, m, N, N_1, α and x. The rate of heat transfer is numerically evaluated for different variations of the governing parameters.

Keywords: Vertical Wavy Channel, Quadratic Density Temperature Variation, Hall Effects, Radiation.

Introduction: It has been established [9] that channels with diverging – converging geometries augment the transportation of heat transfer and momentum. As the fluid flows through a tortuous path viz., the dilated – constricted geometry, there will be more intimate contact between them. The flow takes place both axially (primary) and transversely (secondary) with the secondary velocity being towards the axis in the fluid bulk rather than confining within a thin layer as in straight channels. Hence it is advantageous to go for converging-diverging geometries for improving the design of heat transfer equipment. Keeping these applications in view several authors (33,31,32,15,8,19,30,10,14,3,11) have studies heat transfer in wavy channel under vertical conditions.

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Analysis of the Flow:

On introducing the following non-dimensional variables

$$(x', z') = (x, z)/L,\ \psi' = \frac{\psi}{qL},\ \theta = \frac{T - T_2}{T_1 - T_2}$$

the equation of momentum and energy in the non-dimensional form are

$$\nabla^4\psi - M_1^2\nabla^2\psi + \frac{G}{R}\left(\frac{\partial\theta}{\partial x} + 2\gamma\theta\frac{\partial\theta}{\partial x}\right) = R\left(\frac{\partial\psi}{\partial z}\frac{\partial(\nabla^2\psi)}{\partial x} - \frac{\partial\psi}{\partial x}\frac{\partial(\nabla^2\psi)}{\partial z}\right) \quad (2.16)$$

$$PR\left(\frac{\partial\psi}{\partial x}\frac{\partial\theta}{\partial z} - \frac{\partial\psi}{\partial z}\frac{\partial\theta}{\partial x}\right) = \nabla^2\theta + \alpha + \left(\frac{4}{3N_1}\frac{\partial^2\theta}{\partial x^2}\right) \quad (2.17)$$

Introduce the transformation such that

$$\bar{x} = \delta x, \frac{\partial}{\partial x} = \delta\frac{\partial}{\partial\bar{x}} \quad \text{Then} \quad \frac{\partial}{\partial x} \approx O(\delta) \to \frac{\partial}{\partial\bar{x}} \approx O(1)$$

Assuming the slope δ of the wavy boundary to be small we take

$$\psi(x, z) = \psi_0(x, y) + \delta\psi_1(x, z) + \delta^2\psi_2(x, z) + \ldots\ldots\ldots \quad (3.1)$$

$$\theta(x, z) = \theta_0(x, z) + \delta\theta_1(x, z) + \delta^2\theta_2(x, z) + \ldots\ldots\ldots$$

Let

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$\frac{\partial^2\theta_0}{\partial\eta^2}$

$\frac{\partial^4\psi_0}{\partial\eta^4}$

with
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$\frac{\partial\psi_0}{\partial\eta}$

$\frac{\partial\psi_0}{\partial\eta}$:

and to

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$\psi_1(+1$

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Let $$\eta = \frac{x}{f(\bar{z})} \tag{3.2}$$

Substituting (3.1) in equations (2.16)&(2.17) and using (3.2) and equating the like powers of δ the equations and the respective boundary conditions to the zeroth order are

$$\frac{\partial^2\theta_0}{\partial\eta^2} = -(\alpha_1 f^2) \tag{3.3}$$

$$\frac{\partial^4\psi_0}{\partial\eta^4} - \left(M_1^2 f^2\right)\frac{\partial^2\psi_0}{\partial\eta^2} = -\frac{Gf^3}{R}\left(\frac{\partial\theta_0}{\partial\eta} + 2\gamma\theta_0\frac{\partial\theta_0}{\partial\eta}\right) \tag{3.4}$$

with

$$\psi_0(+1) - \psi_0(-1) = 1$$

$$\frac{\partial\psi_0}{\partial\eta} = 0,\ \frac{\partial\psi_0}{\partial\bar{z}} = 0,\quad \theta_0 = 1 \quad at\ \ \eta = -1 \tag{3.5}$$

$$\frac{\partial\psi_0}{\partial\eta} = 0,\ \frac{\partial\psi_0}{\partial\bar{z}} = 0,\quad \theta_0 = 0 \quad at\ \ \eta = +1$$

and to the first order are

$$\frac{\partial^2\theta_1}{\partial\eta^2}_1 = P_1 Rf\left(\frac{\partial\psi_0}{\partial\eta}\frac{\partial\theta_0}{\partial\bar{z}} - \frac{\partial\psi_0}{\partial\bar{z}}\frac{\partial\theta_0}{\partial\eta}\right) \tag{3.6}$$

$$\frac{\partial^4\psi_1}{\partial\eta^4} - \left(M_1^2 f^2\right)\frac{\partial^2\psi_1}{\partial\eta^2} = -\frac{Gf^3}{R}\left(\frac{\partial\theta_1}{\partial\eta} + 2\gamma(\theta_0\frac{\partial\theta_1}{\partial\eta} + \theta_1\frac{\partial\theta_0}{\partial\eta})\right) + Rf\left(\frac{\partial\psi_0}{\partial\eta}\frac{\partial^3\psi_0}{\partial z^3} - \frac{\partial\psi_0}{\partial\bar{z}}\frac{\partial^3\psi_0}{\partial x\partial z^2}\right) \tag{3.7}$$

with

$$\psi_1(+1) - \psi_1(-1) = 0$$

$$\frac{\partial\psi_1}{\partial\eta} = 0,\ \frac{\partial\psi_1}{\partial\bar{z}} = 0,\quad \theta_1 = 0,\quad at\ \ \eta = -1 \tag{3.8}$$

$$\frac{\partial\psi_1}{\partial\eta} = 0,\ \frac{\partial\psi_1}{\partial\bar{z}} = 0,\quad \theta_1 = 0\ .at\ \ \eta = +1$$

Solutions of the Problem: Solving the equations (3.3), (3.4)&(3.6),(3.8) subject to the boundary conditions (3.5).we obtain

$$\theta_0 = 0.5h^2(1-\eta^2) + 0.5(1-\eta)$$

$$\psi_0 = a_{19}Ch(\beta_1\eta) + a_{20}Sh(\beta_1\eta) + a_{21}\eta + a_{22} + \phi_1(\eta)$$

$$\phi_1(\eta) = a_{10}\eta^5 + a_{11}\eta^4 + a_{16}\eta^3 + a_{17}\eta^2 + a_{18}\eta + a_{15}$$

Shear Stress and Nusselt Number: The stress tensor for the motion on the boundaries is given by

$$\sigma_{ij} = -p\delta_{ij} + 2\mu e_{ij}$$

where

$$e_{xx} = \frac{\partial u}{\partial x}, e_{zz} = \frac{\partial w}{\partial z}$$

$$e_{xz} = 0.5(\frac{\partial u}{\partial z} + \frac{\partial w}{\partial x})$$

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stress on the walls $\eta = \pm 1$, in the non-dimensional form is given by

$(e_{11}(1-f'^2)+(e_{11}-e_{33})f'/(1+f'^2)$

terms of non-dimensional variables, we obtain the non-dimensional shear stress is

$$)_{\eta=1} = \frac{f^2(1+f'^2)c_{51}+\delta(f^2(1-f'^2)c_{55}-2(f'/f)c_{53})+O(\delta^2)}{(1+f'^2)}$$

$$\tau)_{\eta=-1} = \frac{f^2(1+f'^2)c_{52}+\delta(f^2(1-f'^2)c_{56}-2(f'/f)c_{54})+O(\delta^2)}{(1+f'^2)}$$

The rate of heat transfer (Nusselt Number) on the walls has been calculated using the formula

$$Nu = \frac{1}{f(\theta_m-\theta_w)}\left(\frac{\partial\theta}{\partial\eta}\right)_{\eta=\pm1}$$

where

$$\theta_m = 0.5\int_{-1}^{1}\theta\, d\eta$$

$$(Nu)_{\eta=1} = \frac{1}{f\theta_m}(a_{54}+\delta\ b56)$$

$$(Nu)_{\eta=-1} = \frac{1}{f(\theta_m-1)}(b_{54}+\delta\ b_{55})$$

$$\theta_m = b_{57}+\delta\, b_{58}$$

Discussion of the Numerical Results: In the analysis we investigate the effect of quadratic density temperature variation, Hall currents and surface geometry on convective heat transfer flow of a viscous electrically conducting fluid through a porous medium in vertical wavy channel bounded by wavy walls situated at $\eta = \pm 1$. The velocity components u, w and θ are shown in figs 1-18 for different values of M, m, N, β, γ, λ.

1) From fig. 1 we find that the magnitude of axial velocity enhances with $M \le 4$ and reduces with higher $M \ge 6$.
2) An increase in Hall parameter 'm' depreciates |w| everywhere in the region(fig.2).
3) Higher the radiative heat flux larger |w| in entire flow region(fig3).
4) The variation of w with β shows that higher the dilation of the channel walls larger |w| in the flow region (fig. 4).
5) An increase in the inclination of the magnetic field leads to an enhancement in |w|(fig.5).
6) An increase in the density ratio (γ) results in an enhancement in |w| everywhere in the region(fig6).
7) Higher the Lorentz force larger/lesser the permeability at porous medium larger |u| in the flow region (fig. 7).
8) An increase Hall parameter 'm' depreciates |u| everywhere in the flow region (fig.8).
9) The variation u with radiation parameter N reveals that higher the radiative heat flux larger |u| in the region (fig. 9).
10) The influence of the surface geometry on u is shown in fig. 10. It is found that higher the dilation of channel walls larger |u| and the increment in |u| is remarkably larger with higher β.
11) The variation of u with density ratio γ shows that the region of transition from negative to positive u extends towards the midregion and |u| enhances with increase in γ (fig. 11).
12) An increase in the inclination of the magnetic field leads to an enhancement in |u| (fig. 12).
13) Higher the Lorentz force/lesser the permeability of porous medium smaller the actual temperature (fig. 13).
14) From fig. 14 we find that the actual temperature experience an enhancement with increase in Hall parameter 'm'.
15) The variation of θ with radiation parameter N, shows that higher the radiative heat flux larger the actual temperature(fig.15).
16) The temperature experience an enhancement with increase in the dilation of channel walls.(fig.16)
17) An increment γ or λ results in a depreciation in actual temperature (fig.17 & 18).Moving along the axial distance of the channel walls the actual temperature depreciates with x.

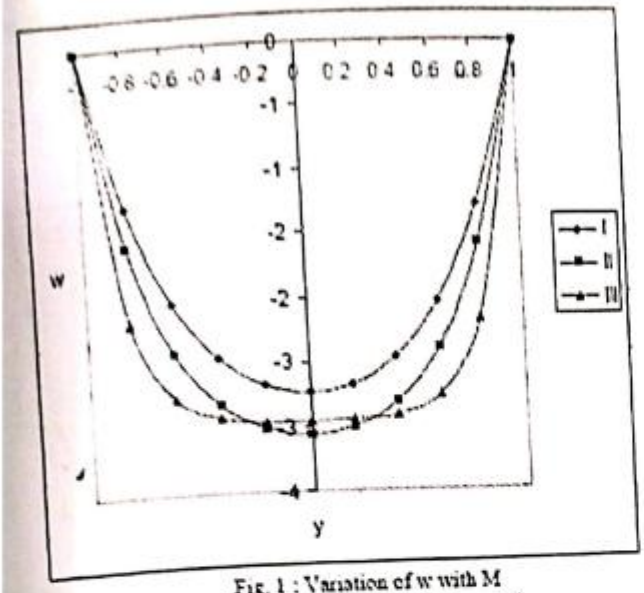

Fig. 1 : Variation of w with M

	I	II	III
M	2	4	10

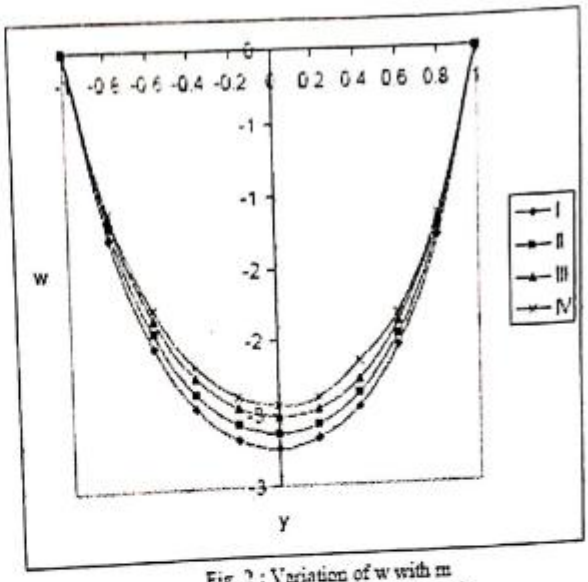

Fig. 2 : Variation of w with m

	I	II	III	IV
m	0.5	1.5	2.5	3.5

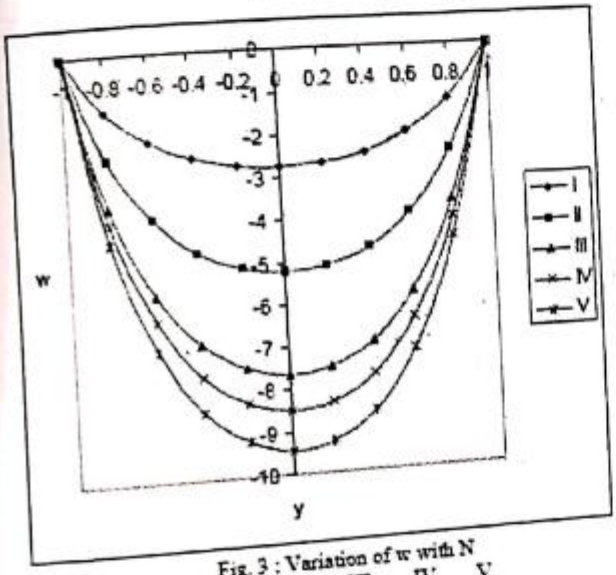

Fig. 3 : Variation of w with N

	I	II	III	IV	V
N	0.5	1.5	5	10	100

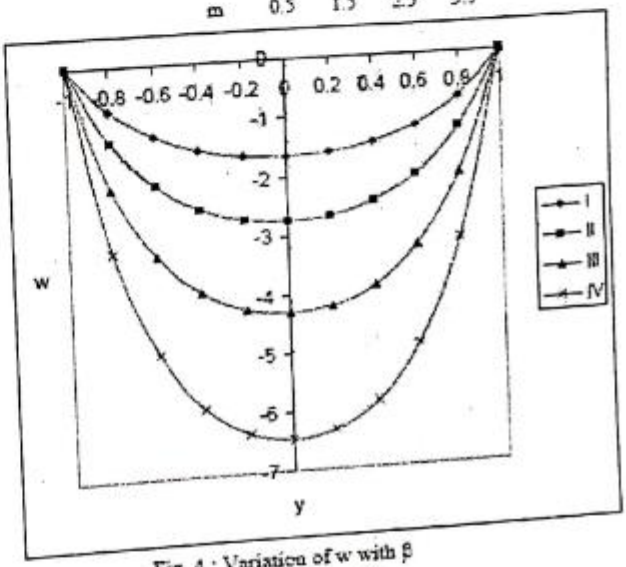

Fig. 4 : Variation of w with β

	I	II	III	IV
β	0.3	0.5	0.7	0.9

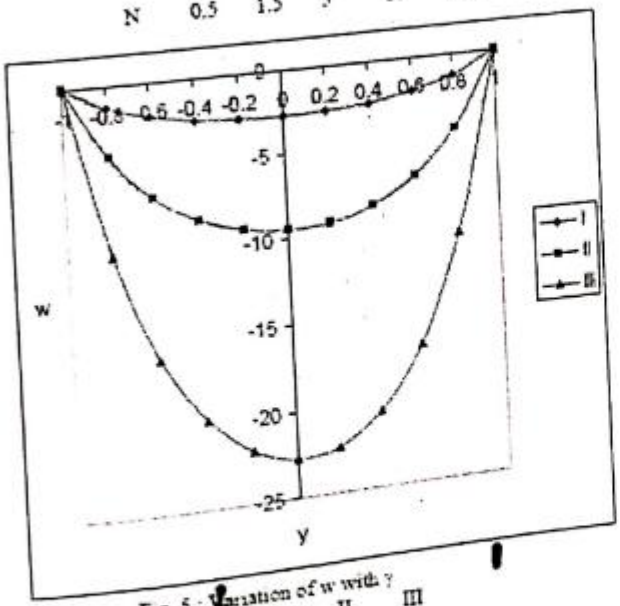

Fig. 5 : Variation of w with γ

	I	II	III
γ	0.5	1.5	3.5

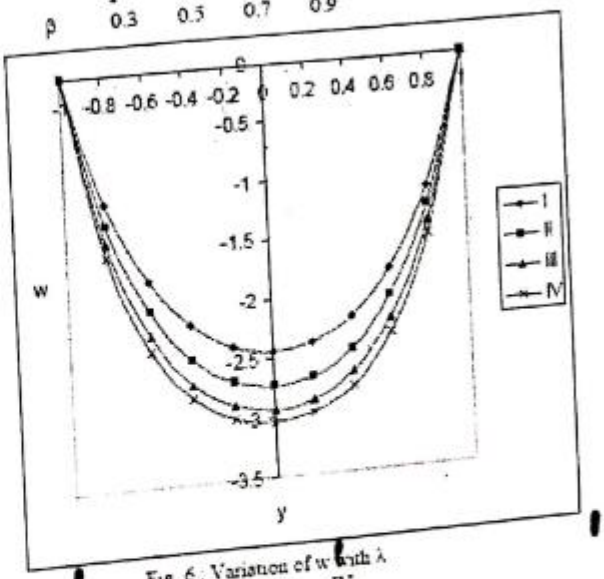

Fig. 6 : Variation of w with λ

	I	II	III	IV
λ	0.25	0.5	0.75	1

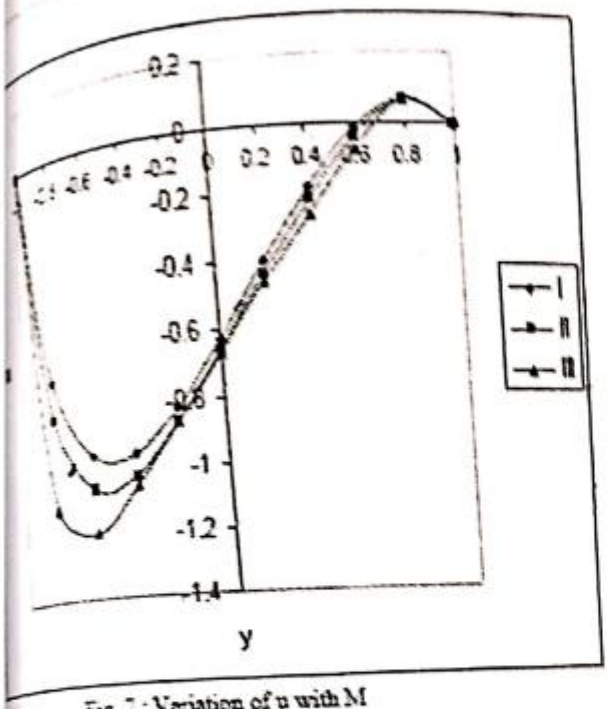

Fig. 7 : Variation of u with M

	I	II	III
M	2	4	10

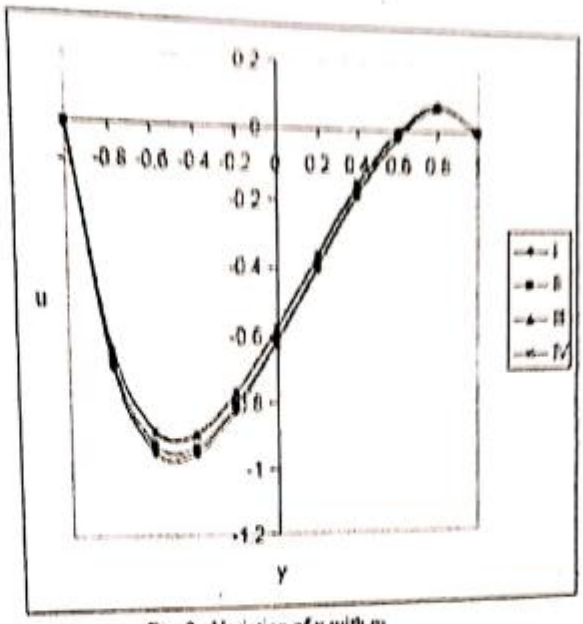

Fig. 8 : Variation of u with m

	I	II	III	IV
m	0.5	1.5	2.5	3.5

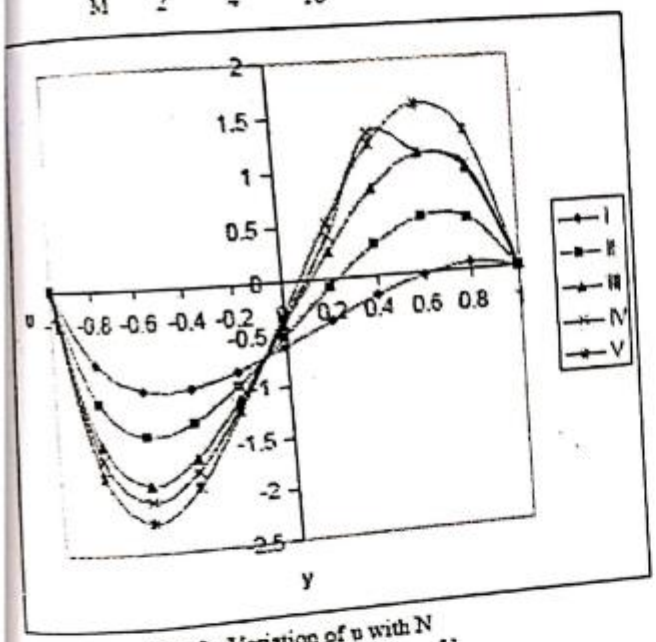

Fig. 9 : Variation of u with N

	I	II	III	IV	V
N	0.5	1.5	5	10	100

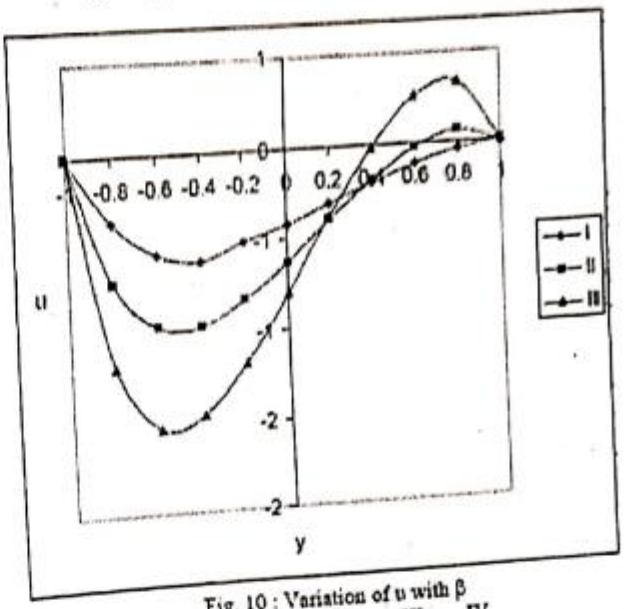

Fig. 10 : Variation of u with β

	I	II	III	IV
β	0.3	0.5	0.7	0.9

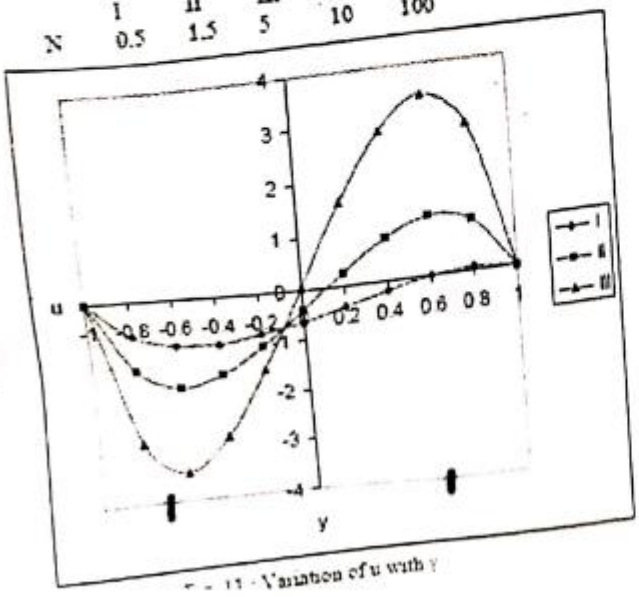

Fig. 11 : Variation of u with γ

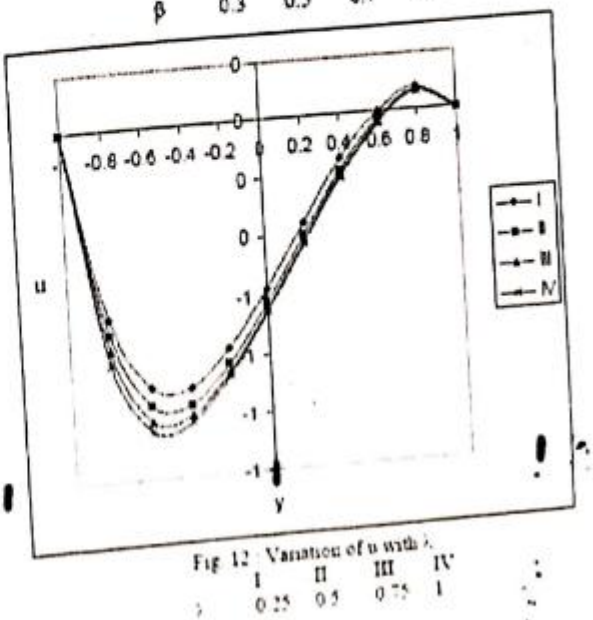

Fig. 12 : Variation of u with λ

	I	II	III	IV
λ	0.25	0.5	0.75	1

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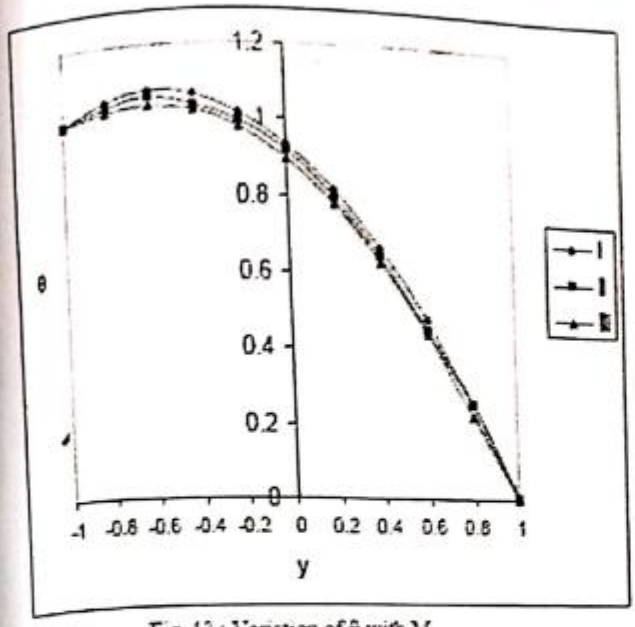

Fig. 13 : Variation of θ with M

	I	II	III
M	2	4	10

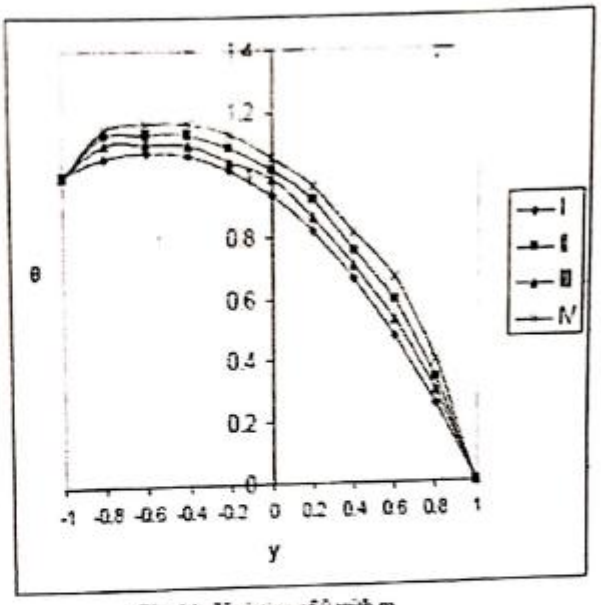

Fig. 14 : Variation of θ with m

	I	II	III	IV
m	0.5	1.5	2.5	3.5

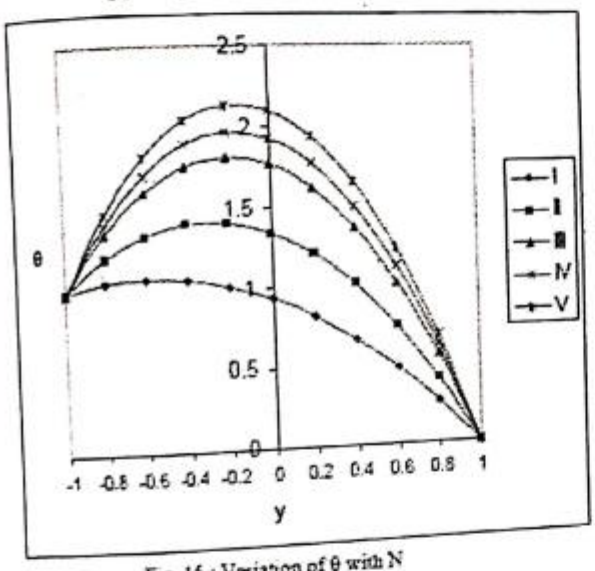

Fig. 15 : Variation of θ with N

	I	II	III	IV	V
N	0.5	1.5	5	10	100

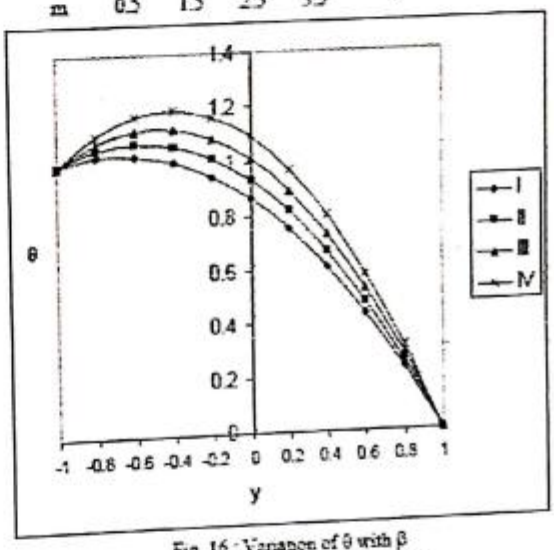

Fig. 16 : Variation of θ with β

	I	II	III	IV
β	0.3	0.5	0.7	0.9

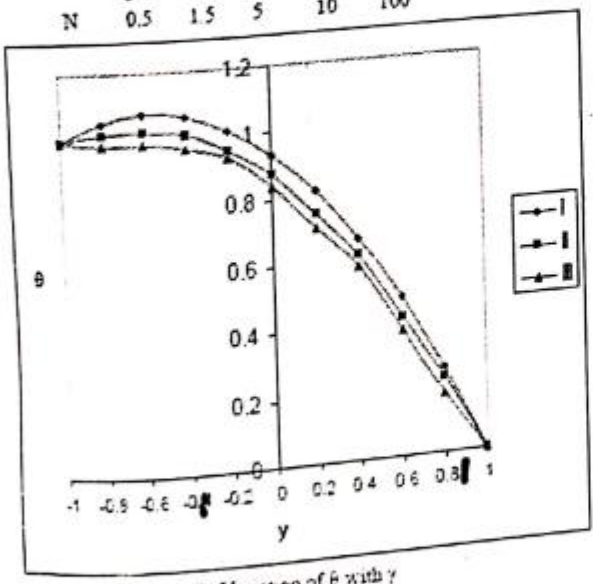

Fig. 17 : Variation of θ with γ

	I	II	III
	0.5	1.5	3.5

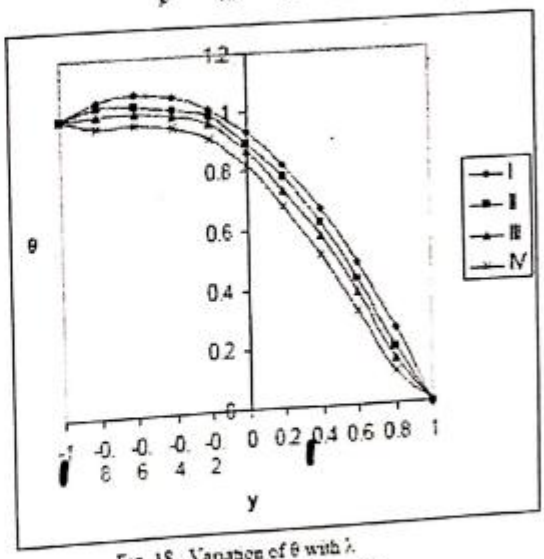

Fig. 18 : Variation of θ with λ

	I	II	III	IV
	0.25	0.5	0.75	1

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Magnetohydrodynamic Flow of Casson Fluid through a Vertical Deformable Porous Stratum

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Abstract: *Magnetohydrodynamic (MHD) flow of Casson fluid through a vertical deformable porous stratum is studied. The governing ordinary differential equations of the fluid velocity, the displacement and the heat transfer are solved numerically using shooting technique. The effects of pertinent parameters on the flow velocity, the solid displacement and the heat transfer are discussed through graphs. The skin friction coefficient is displayed through table. It is noticed that the effect of increasing Casson parameter is to increase the skin friction in the deformable stratum.*

Keywords: *MHD; Casson parameter; deformable layer; shooting technique.*

NOMENCLATURE

g	acceleration due to gravity	ϕ^f	the volume fraction components of the fluid phase, $\phi^f + \phi^s = 1$.
K	drag coefficient	μ_f	coefficient of the viscosity
K_0	thermal conductivity	δ	measure of the viscous drag of the outside fluid relative to drag in the porous medium
p	pressure	η	ration of the bulk fluid viscosity to the apparent fluid viscosity in the porous layer
T	temperature	M	Magnetic fluid parameter
T_0	ambient temperature	σ	electrical conductivity
N	buoyancy parameter	B_0	Magnetic field strength
μ_a	apparent viscosity of the fluid in the porous material	τ	shear stress
ρ	density of the fluid	Nu	Nusselt number
β_1	coefficient of linear thermal expansion of the fluid		
β	the Casson parameter		
ϕ^s	volume fraction components of solid phase		

I. INTRODUCTION

In recent years a great deal of interest has been generated to study heat transfer in fluid flows through porous media because of their extensive applications in engineering, biology and medicine. These include heat exchange between soil and atmosphere, flow of moisture through porous blood vessels can be better understood with theory of flow through deformable porous media. The study of flows through deformable porous materials was initiated by Terzaghi [1] and further developed by Biot [2,3], Atkin and Crane [4] and Kenyon [5] this deformation theory is applied to the study of flows in biological tissue layers and articular cartilage. Dariusz Gawin et al. [6] developed coupled heat, water and gas flow in deformable porous media. Barry et al. [7] studied fluid flow over a thin deformable porous layer. Flow of Newtonian fluid a channel with deformable porous walls was reported by Ranganatha et al. [8]. Sreenadh et al. [9] studied MHD Couette flow of a Jeffrey fluid over a deformable porous player. Gopi Krishna et al. [10] developed an entropy generation on viscous fluid in the inclined deformable porous medium. Free convection flow of a Jeffrey fluid through a vertical deformable porous stratum and MHD free surface flow of a Jeffrey fluid over a deformable porous layer was

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discovered by Sreenadh et al. [11, 12]. Hartmann flow over a permeable bed was demonstrated by Rudraiah et al. [13]. Sreenadh et al. [14] discussed viscous fluid flow in an inclined channel with deformable porous medium. Gopi Krishna et al. [15] developed viscous flow and heat transfer in a vertical channel with deformable porous medium. Effect of heat transfer on free surface flow of a Jeffrey fluid over a deformable permeable bed and flow of a Jeffrey fluid between finite deformable porous layers was reported by Sreenadh et al. [16, 17]. Asghar et al. [18] studied Flow and heat transfer analysis in a deformable channel Selvi et al. [19] investigated viscous flow of Jeffrey fluid in an inclined channel through deformable porous media. Gopi Krishna et al. [20] studied an entropy generation and heat transfer in a Casson fluid flow through a vertical deformable porous stratum. Krishna Murthy [21] discovered MHD Poiscuille flow of a Jeffrey fluid over a deformable porous layer. Syed Tauseef Mohyud-Din et al. [22] founded flow of a radioactive Casson fluid through a deformable asymmetric porous channel. Sreenadh et al. [23] studied effects of free convection on steady flow through a vertical deformable porous layer with constant heat source. Rudraiah et al. [24] studied natural convection through vertical porous stratum. The present study deals with Magnetohydrodynamic (MHD) flow of Casson fluid through a vertical deformable porous stratum. Here Casson parameter $\beta \to \infty$ this reduces to Newtonian model. The velocity, displacement and temperature are obtained graphically while the skin friction coefficient is calculated numerically.

B. Mathematical Formulation of The problem

Consider, the steady MHD flow of Casson fluid through a vertical deformable porous stratum as shown in Figure 1. The x - axis is taken midway in the channel and y - axis perpendicular to it. The deformations are assumed to be small and are predominantly in the direction. It is assumed that heat is generated within the fluid by both viscous and Darcy dissipations. The walls are placed at a distance $2b$ and maintained at a constant temperature T_1. A pressure gradient $\frac{\partial p}{\partial x}$ is applied producing an axially directed flow.

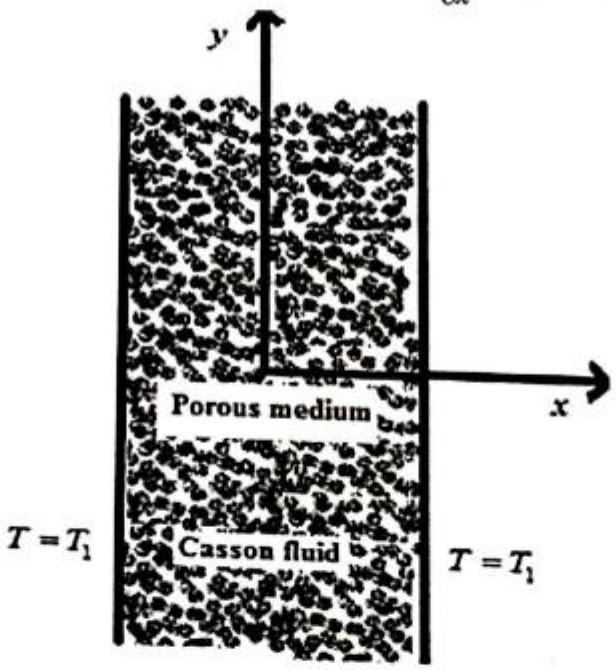

Figure 1. Physical model of the problem

The governing equations forthe flow velocity, the displacement and the heat transfer are shown below

$$2\mu_a\left(1+\frac{1}{\beta}\right)\frac{\partial^2 v}{\partial y^2}-\phi^f\frac{\partial p}{\partial x}-\sigma B_0^2 v-Kv+\rho g\beta_1\left(T-T_0\right)=0 \qquad (1)$$

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$$\mu\frac{\partial^2 u}{\partial y^2}-\phi'\frac{\partial p}{\partial x}+Kv=0 \tag{2}$$

$$\frac{\partial^2 T}{\partial y^2}+\frac{2\mu_a}{K_0}\left(1+\frac{1}{\beta}\right)\left(\frac{\partial v}{\partial y}\right)^2+\frac{K}{K_0}v^2=0 \tag{3}$$

The boundary conditions are

$$\left.\begin{aligned}&\frac{dv}{dy}=0,\frac{du}{dy}=0,\frac{dT}{dy}=0\,at\,y=0\\&v=0,u=0,T=T_1\,at\,y=b\end{aligned}\right\} \tag{4}$$

C. Non- Dimensionalization of The Flow Quantities

We introduce the following non-dimensional quantities are

$$\left.\begin{aligned}&y^*=\frac{y}{b},\ y^*=\frac{x}{b},\ v^*=\frac{2\mu_a v}{\rho g\beta_1 b^2(T_1-T_0)}\\&u^*=\frac{\mu u}{\rho g\beta_1 b^2(T_1-T_0)},\theta=\frac{T-T_0}{T_1-T_0},p^*=\frac{p}{\rho g\beta_1 b(T_1-T_0)}\end{aligned}\right\} \tag{5}$$

In view of the above dimensionless quantities, the equations (1)-(4) take the following form. The asterisks (*) are neglected here after

$$\left(1+\frac{1}{\beta}\right)\frac{d^2v}{dy^2}-\phi' G-\delta\eta v-M^2v+\theta=0 \tag{6}$$

$$\frac{d^2u}{dy^2}-\phi'\frac{dp}{dx}+\delta\eta v=0 \tag{7}$$

$$\frac{d^2\theta}{dy^2}+N\left(1+\frac{1}{\beta}\right)\left(\frac{dv}{dy}\right)^2+N\delta\eta v^2=0 \tag{8}$$

Where

$\delta=\frac{Kb^2}{\mu_f}$, $\eta=\frac{\mu_f}{2\mu_a}$, $N=\frac{\rho g^2\beta_1^2 b^4(T_1-T_0)}{2K_0\mu_a}$, $M^2=\frac{\sigma B_0^2 b^2}{2\mu_a}$, $G=\frac{dp}{dx}$ is the pressure gradient

The boundary conditions are

$$\left.\begin{aligned}&\frac{dv}{dy}=0,\frac{du}{dy}=0,\frac{d\theta}{dy}=0 \quad at \quad y=0\\&v=0,u=0,\theta=1 \qquad at \quad y=1\end{aligned}\right\} \tag{9}$$

D. Skin friction Coefficient

The skin friction in the velocity field at the wall in non-dimensional form is given by

$$\tau=\left(1+\frac{1}{\beta}\right)\left(\frac{dv}{dy}\right)_{at\ y=1} \tag{10}$$

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E. Rate of Heat Transfer

The rate of heat transfer at the wall is given by

$$Nu = -\left(\frac{d\theta}{dy}\right)_{at\ y=1} \tag{11}$$

II. RESULTS AND DISCUSSION

The present study deals with MHD flow of Casson fluid through a vertical deformable porous stratum. The coupled non linear governing equations are solved numerically using Runge-Kutta fourth order along with shooting technique. The effects of pertinent parameters on the velocity, the displacement and the temperature are displayed graphically. The skin friction coefficient is calculated numerically and is shown in Table-1. effects of magnetic parameter on velocity $v(y)$, displacement $u(y)$ and temperature $\theta(y)$ are shown in Figures 2, 3 and 4. We noticed the velocity, displacement and temperature are decrease with increasing values of magnetic field parameter M. This reduction causes the Lorentz force associated with the magnetic field increases and it produces more resistance to the transport phenomena in the vertical porous stratum. The influence of Casson parameter on velocity $v(y)$, displacement $u(y)$ and temperature $\theta(y)$ are displayed in Figures 5, 6 and 7. We have seen that the velocity, displacement and temperature are decrease with increasing values of Casson parameter β. This fact that the higher values of Casson parameter results the decrease in yield stress (the fluid behaves as a Newtonian fluid when the Casson parameter becomes large).

The variation of fluid velocity $v(y)$, displacement $u(y)$ and temperature $\theta(y)$ are examined with the effect of pressure gradient G is shown in Figures 8-10. We examine that it is reduces for higher values of pressure gradient. The impact of volume fractional of the fluid ϕ^f and viscosity parameter η on velocity $v(y)$, displacement $u(y)$ and temperature $\theta(y)$ are sketched in Figures 11-16. This shows that velocity and temperature are decrease for higher values of volume fraction of the fluid and the opposite nature in displacement. The effect of buoyancy parameter N on fluid velocity $v(y)$, displacement $u(y)$ and temperature $\theta(y)$ are shown in Figures 17-19. We have seen that it is enhance with increasing values of N. The effect of drag coefficient δ on fluid velocity $v(y)$, displacement $u(y)$ and temperature $\theta(y)$ are shown in Figures 20-22. We noticed that the velocity and temperature reduce with increasing drag coefficient δ and the opposite behavior in solid displacement. This fact that increasing viscosity parameter $(\mu_f/2\mu_a)$, gives rise to an increase in the velocity in the porous layer. This shows that the increase in the drag enhances the displacement of solid particles in the deformable porous layer. The magnitude of the skin friction coefficient is evaluated numerically for equation (10) for distinct values of buoyancy parameter N and is shown in Table1. We have seen that the skin friction coefficient at the vertical wall $y = 1$ enhances with higher values of N. The same behavior is noticed in the case of vertical undeformable porous layer Rudraiah *et al.* [24]. Higher skin friction is observed for a given buoyancy force for a non-Newtonian Casson parameter when compared with Newtonian fluid.

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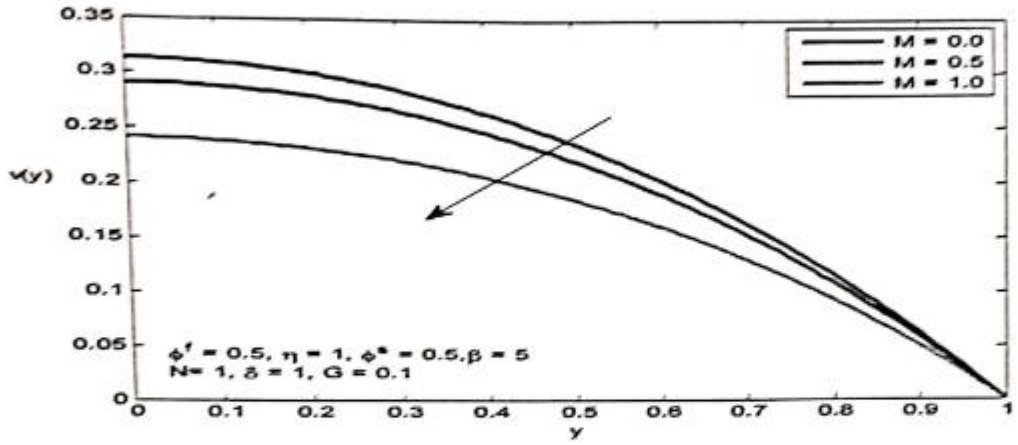

Figure 2. The velocity $v(y)$ for different values of M

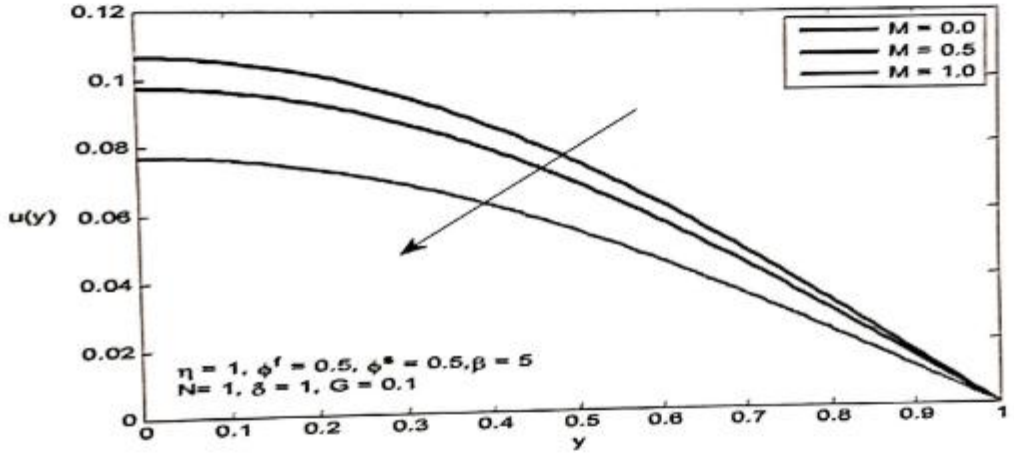

Figure 3. The displacement $u(y)$ for different values of M

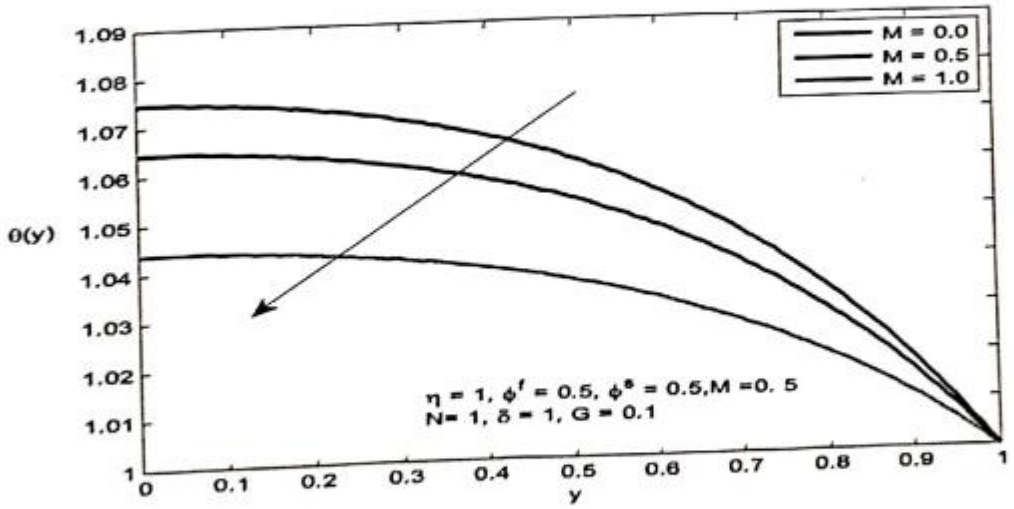

Figure 4. The temperature $\theta(y)$ for different values of M

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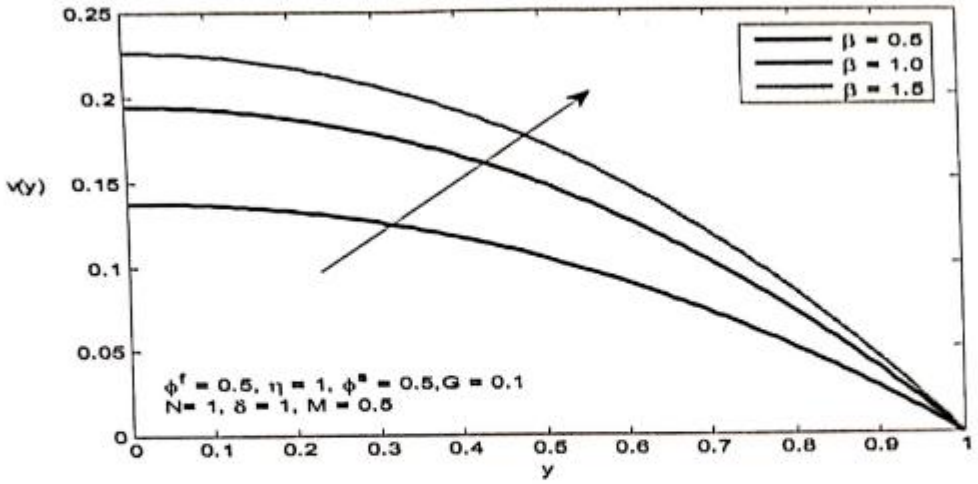

Figure 5. The velocity $v(y)$ for different values of β

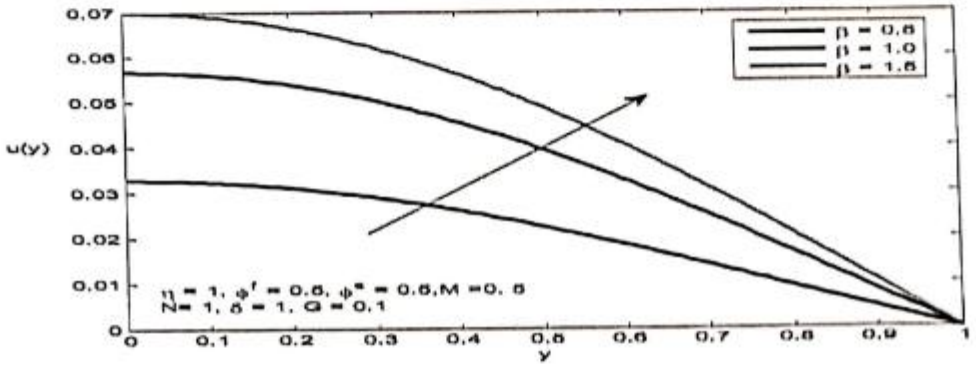

Figure 6. The displacement $u(y)$ for different values of β

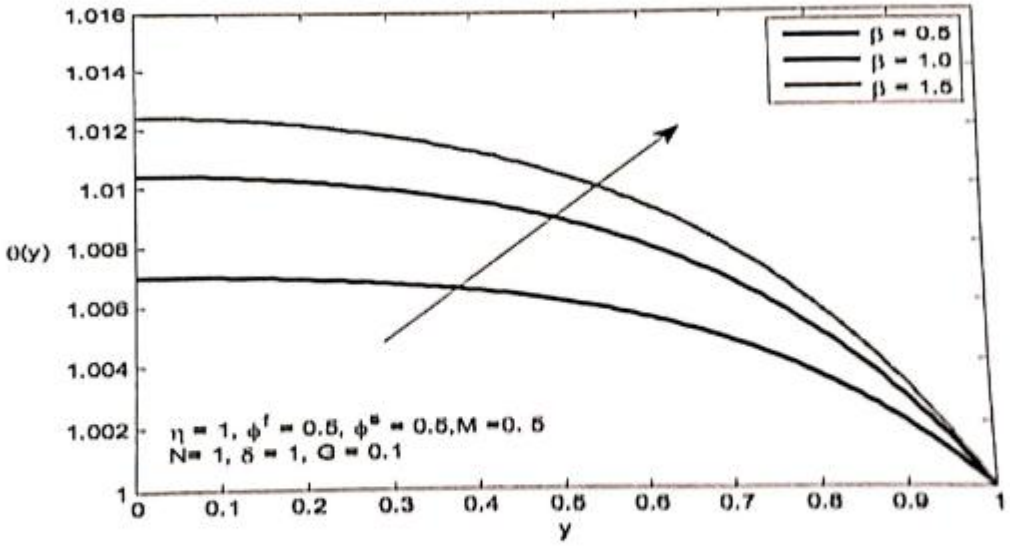

Figure 7. The temperature $\theta(y)$ for different values of β

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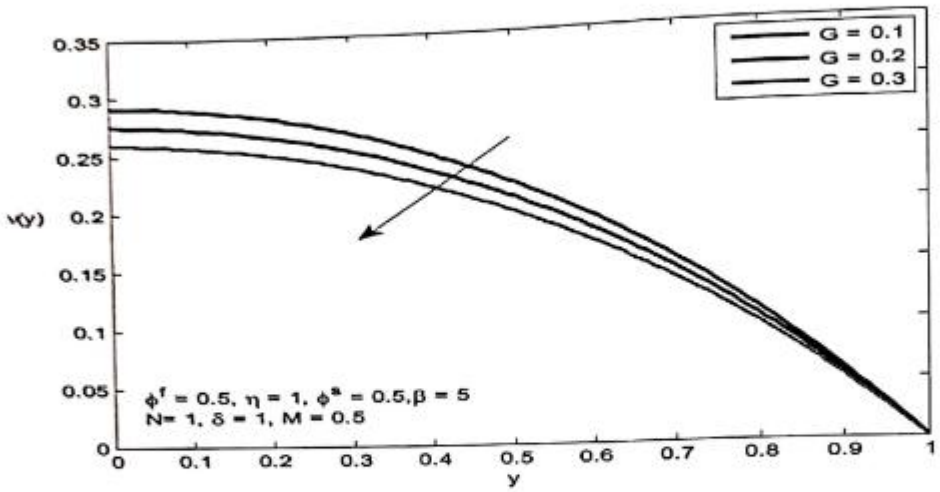

Figure 8. The velocity $v(y)$ for different values of G

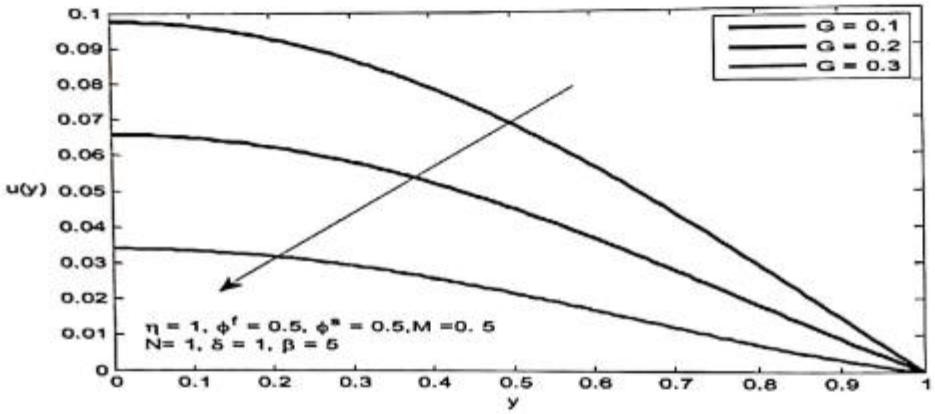

Figure 9. The displacement $u(y)$ for different values of G

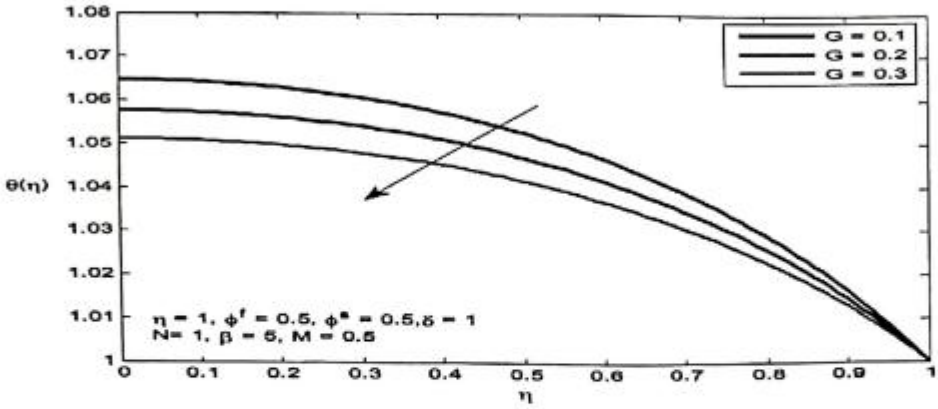

Figure 10. The temperature $\theta(y)$ for different values of G

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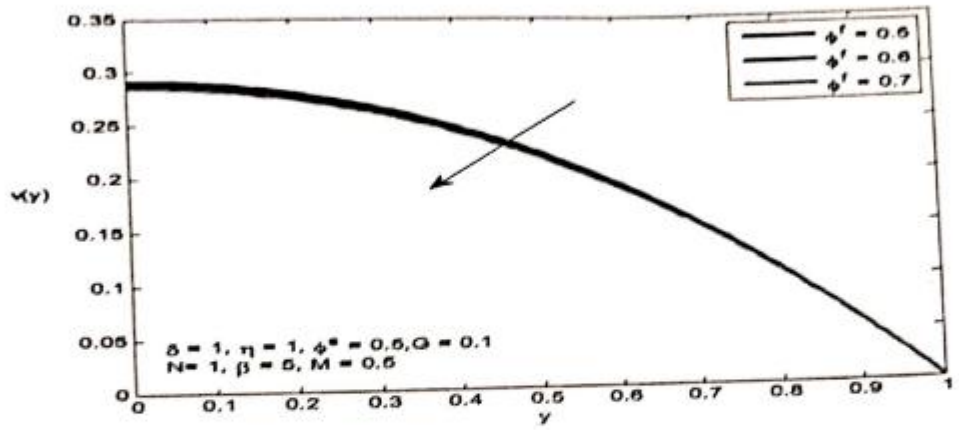

Figure 11. The velocity $v(y)$ for different values of ϕ^f

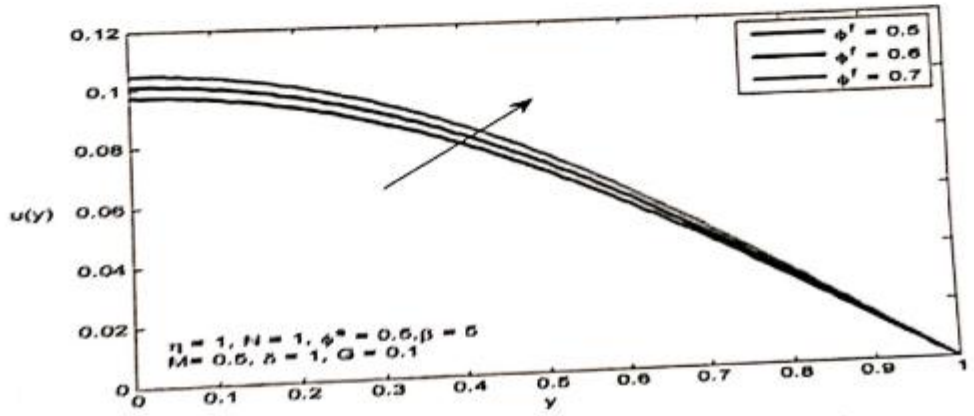

Figure 12. The displacement $u(y)$ for different values of ϕ^f

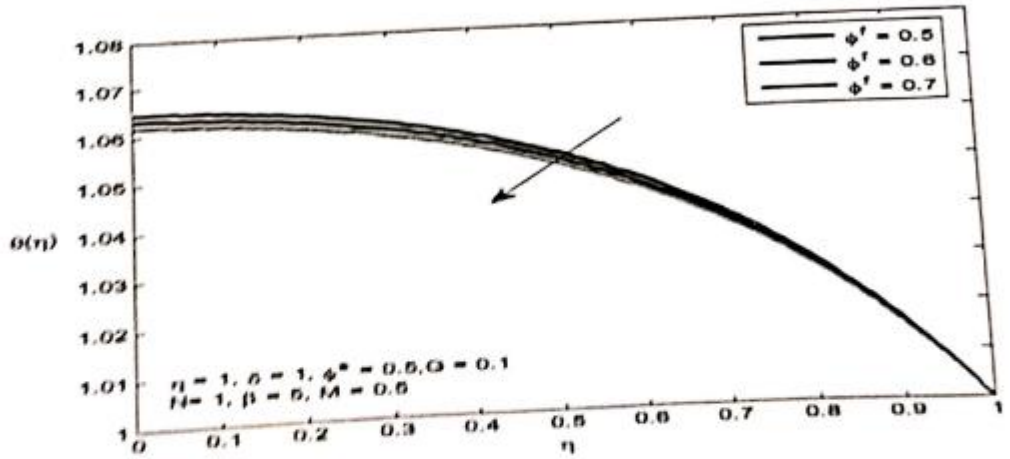

Figure 13. The temperature $\theta(y)$ for different values of ϕ^f

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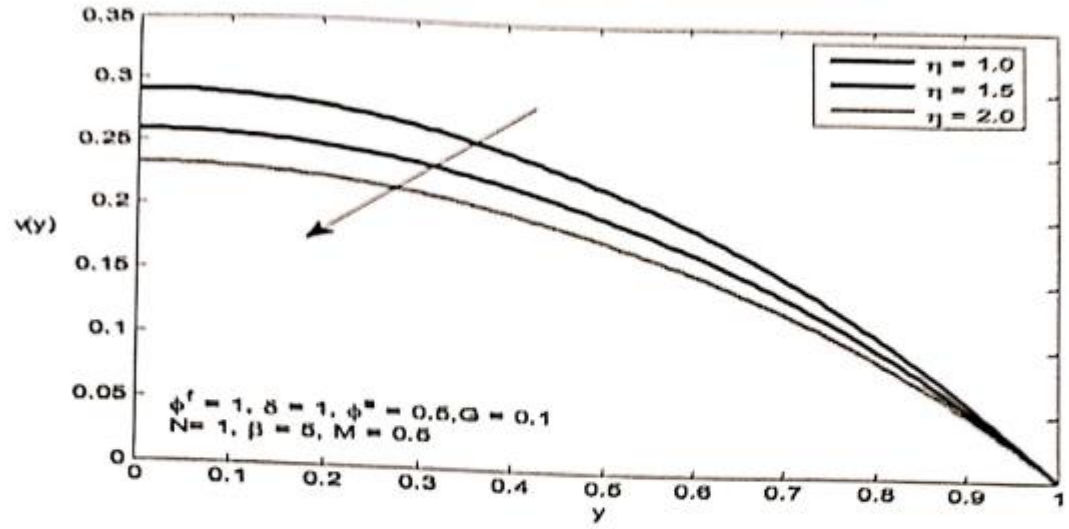

Figure 14. The velocity $v(y)$ for different values of η

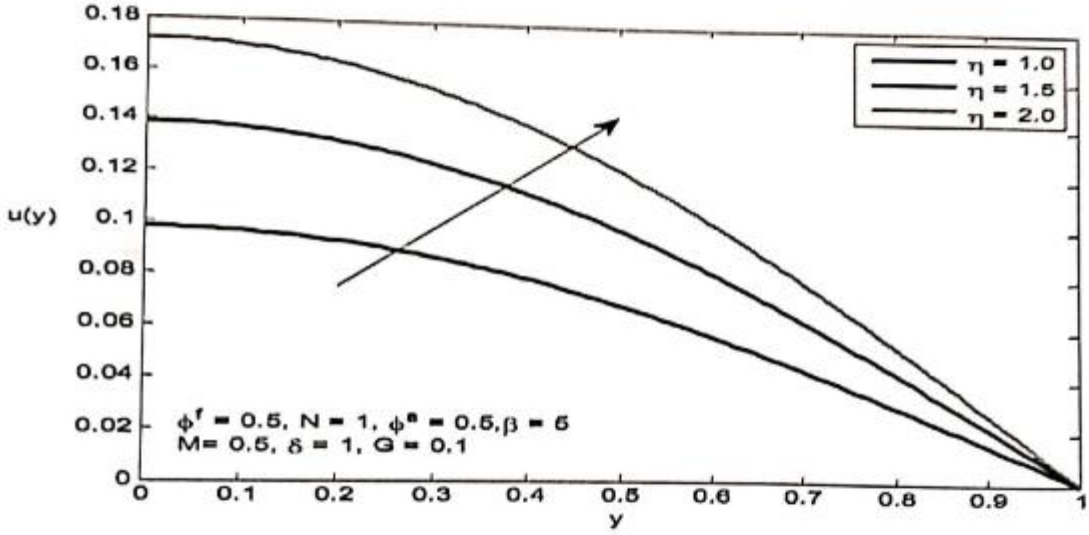

Figure 15. The displacement $u(y)$ for different values of η

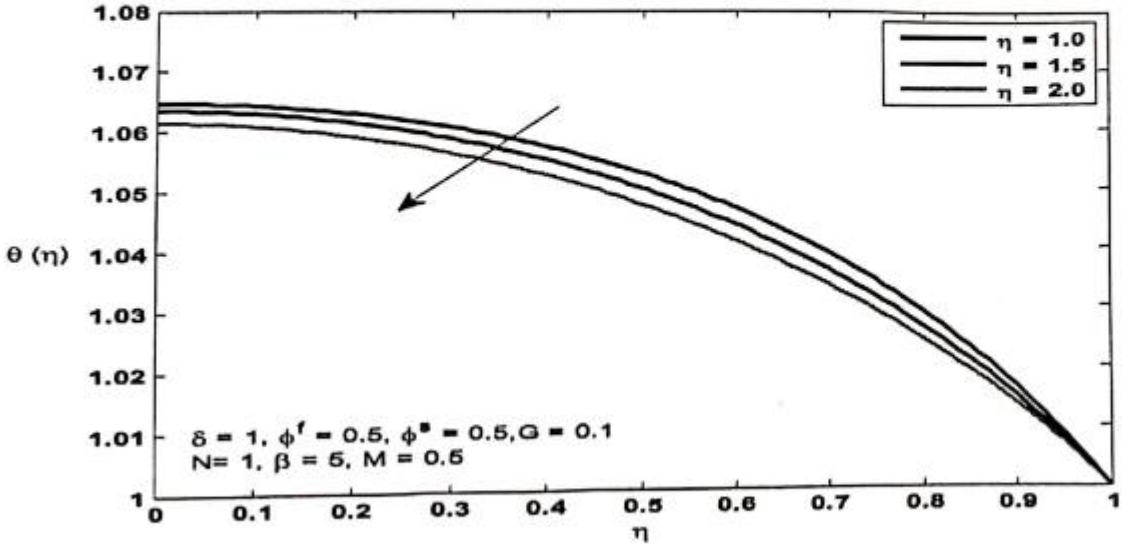

Figure 16. The temperature $\theta(y)$ for different values of η

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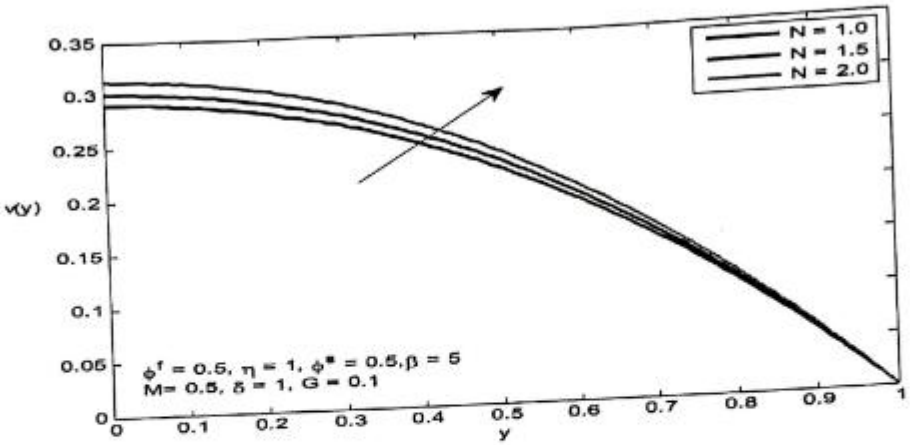

Figure 17. The velocity $v(y)$ for different values of N

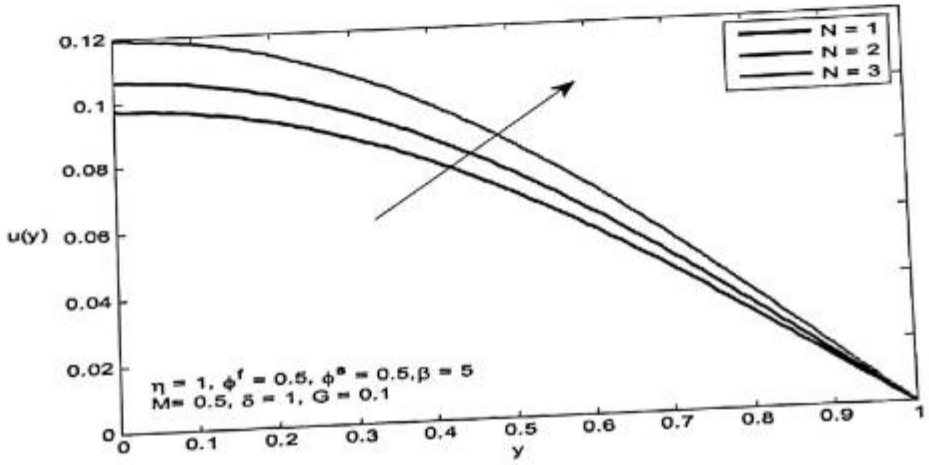

Figure 18. The displacement $u(y)$ for different values of N

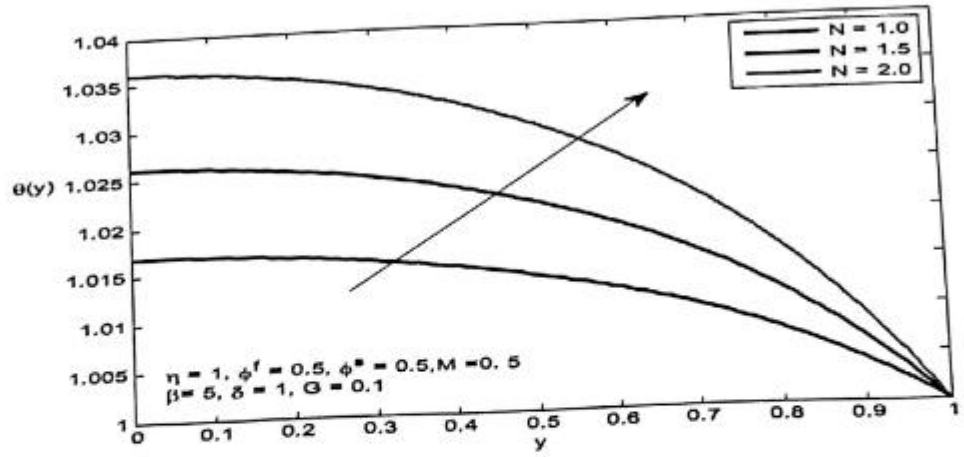

Figure 19. The temperature $\theta(y)$ for different values of N

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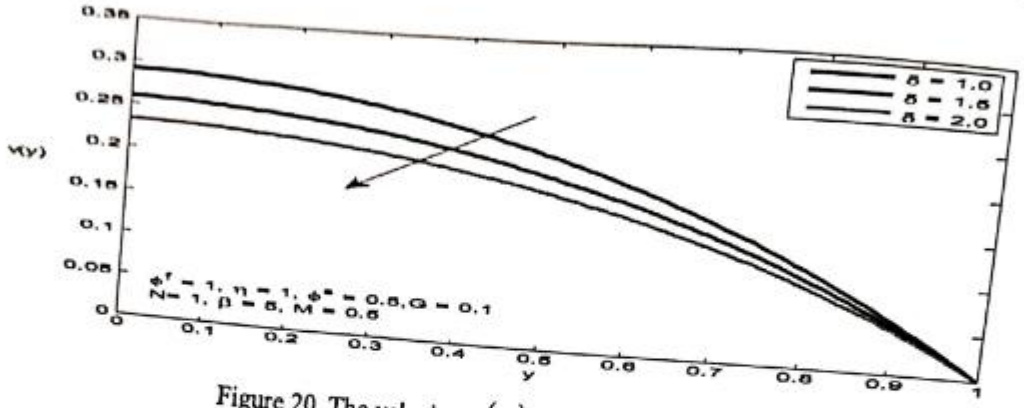

Figure 20. The velocity $v(y)$ for different values of δ

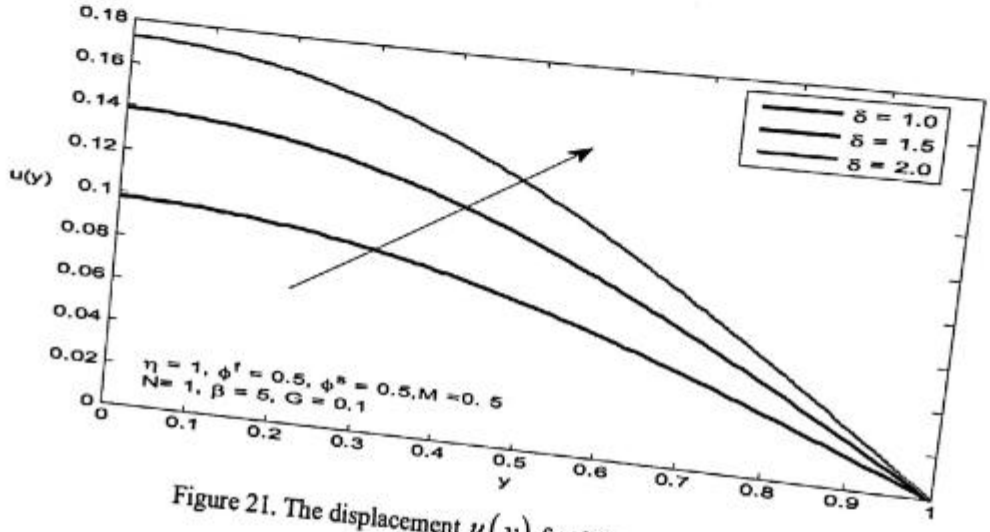

Figure 21. The displacement $u(y)$ for different values of δ

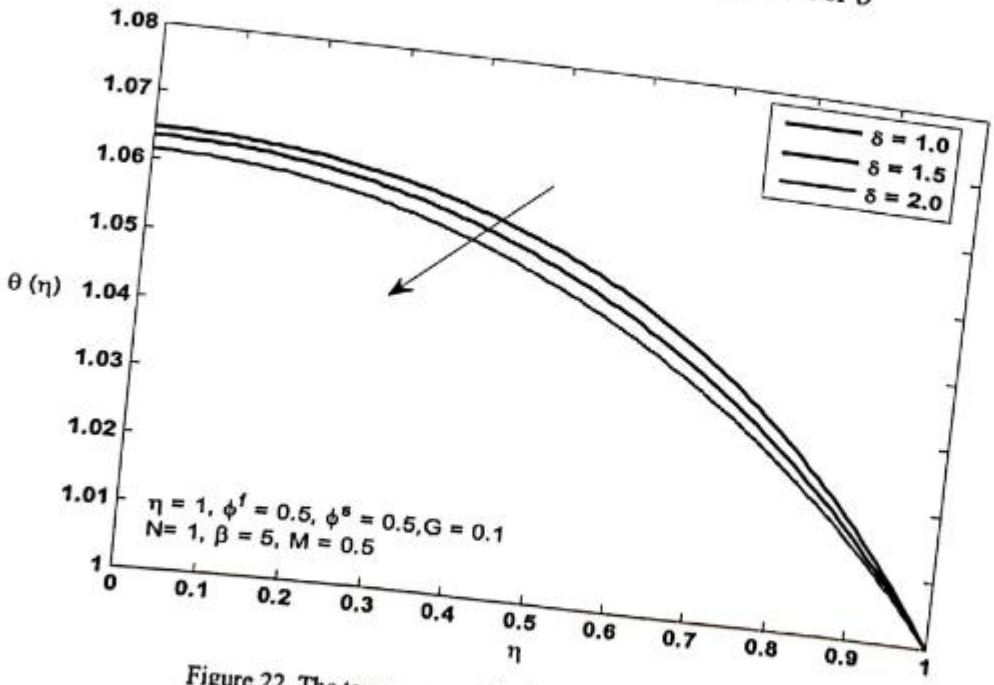

Figure 22. The temperature $\theta(y)$ for different values of δ

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Table 1. The Skin friction coefficient τ at $y = 1$ for different values of N

S.No.		$N=1$	$N=2$	$N=3$
1	Rudraiah *et al.*[24] (undeformable porous layer)	0.8056	0.8497	0.8937
2	Present work (deformable porous layer $M=0, \beta \to \infty$)	0.7252	0.7268	0.7285
3	Present work with ($M=0, \beta \to \infty$)	1.0660	1.3006	1.5352

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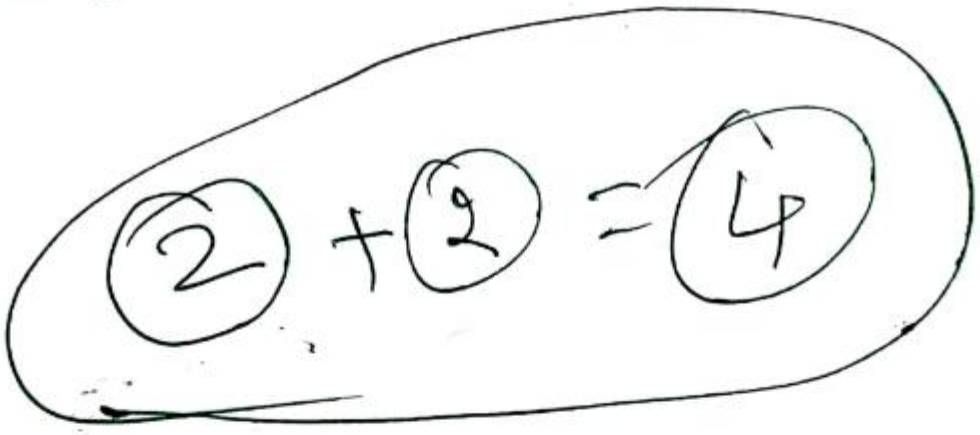

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Use of Social Media among LIS Students of Bangalore University: A Study

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Abstract
The present study aim to study student's perception on usage of social media. The study adopted a survey design and data were collected from the respondents using a questionnaire. The populations of the study are MLISc students of Bangalore University. The results revealed that most of the respondents came to know to use the social media through self-interest. Majority of the respondents are using social media for communication. 47.82% opined that using social media wasting their valuable time.

Keywords: Academic Usage, Social Media, PG students, User survey.

Introduction

According to Mark Zuckerberg, Facebook founder and CEO** "Our community and business continue to grow quickly, and now more than 2 billion people use at least one of our services every day,". The emphasis how social networking is popular and widely used in the world among the people. As social networking is growing, there are enormous opportunities to get the wide range of information, which contributed by the end users. Social media tools like Wikipedia, blogs, SNS, YouTube and Twitter contain various features to attract the users. These features not only for entertainment, communication, and socializing but also benefit for the academic community. There are number of studies are focus on how the social media is useful to the students to support their course related information needs. It will be important to know how the students use the non-library information sources to their academic assignments. The current study is also to explore how the MLISc students of Bangalore University using the social media tools for their academic purpose.

Review of Literature

Asogwa, C et al (2015) study assessed the use of Social Networking Sites and Academic Performance among Students of Tertiary Institutions in Kogi State. The study found that majority (94.1%) of the respondents search for academic information on SNS. The study concludes that the use of social networking sites is, and will continue to remain popular with the digital and virtual generations, SNSs can be a useful instrument in improving academic performance of students of tertiary institutions in Kogi state. Kim & Sim (2015) studied how under graduate students use social media for information seeking purpose. The data was collected using a web survey questionnaire. Social networking sites and blogs are used by female respondents frequently. The study concludes that there is a significant effect of sex when problem solving taking in to account.

Anilkumar & Rajendra kumar(2013) presents the results of their study at Maharshi dayanand University ,Rohtak. The results of the study indicate that 73.33% of the respondents using mobile phones to connect the SNS, and 50% of the respondents satisfies using SNS.

Sei-chngJoanna,Kyung-Sun(2013) analyzed International students everyday life information needs, their usage of Social networking sites. The findings of the study indicate that majority (97 percent) of the respondents frequently used SNS. Colkar (2012) examined the education on face book environment in Selcuk university. The investigator approached through case study and qualitative research. For collection of data semi- structured interview method was adopted. Analysis of data is done by using content analysis. The study found that educational use of face book provides various

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advantages like interaction, ease of access to information, time gain etc. Majority of the respondents opined that teacher supervision must be increased for better usage of face book in the academic purpose. Mazman&Usluel (2010) conducted a survey to test a structural educational model explaining how users could utilize face book for educational purpose. For collection of data the study employed an online survey of the face book users. The participants of the study were university students who were between the ages of 18-23. The study found that the education use of face book has a significant positive relationship with its use for communication, collaboration and material sharing. Zakaria, Watson, & Edwards(2010) studied the use of social media by Malaysian students. They found that students have been using the Internet applications specifically social media for both formal and informal types of learning.

Objectives of the Study

- To know the devices used by the students to use social media.
- To obtain their views on how they join the Social network sites
- To examine the time spent in using the social media
- To get the opinion on the use of social media for academic purpose.
- To identify the problems facing by the students in using the social media.

Methodology

The study used survey research and questionnaire as a tool for the collection of data. The population of the present study is the Post Graduates, who are pursuing Master of Library and Information science course in the Bangalore University, Bangalore. Since the population is small and manageable the investigator chooses census method. A structured closed ended questionnaire was designed in simple English language. The investigator personally distributed the questionnaires to the students who are attended the classes, and received responses from 46 only. The response rate is 94%. The questionnaires responses are entered in SPSS for analysis of data. Frequency tables and charts were used for presentation.

Data Analysis

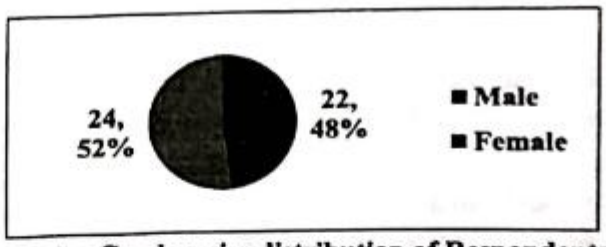

Figure 1: Gender wise distribution of Respondents

The figure 1 shows the gender wise distribution of respondents. It is cleared that majority of the respondents 24(52%) are female, and 22(48%) are male respondents participated in this study.

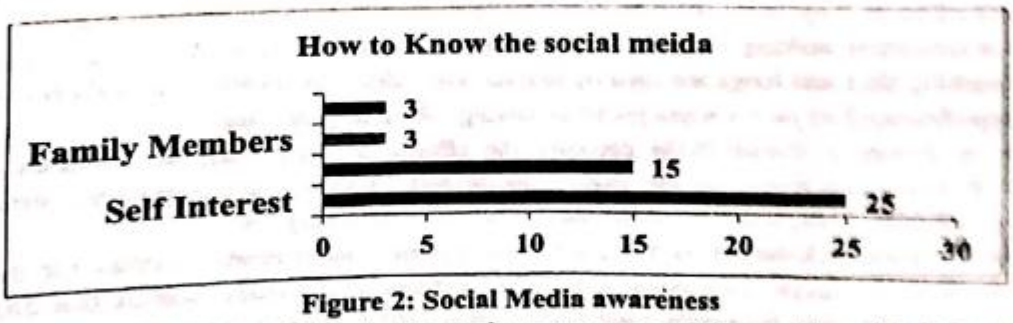

Figure 2: Social Media awareness

The figure 2 explains the data relating to the student awareness of the social media. It is very clear to understand that majority of the respondents 25 (54.3%) opined that their self-interest to aware of social media, followed by friends 15 (32.6%), through family members 3(6.5%) and internet 3 (6.5%). Self-interest is the most dominant reason for using the social media.

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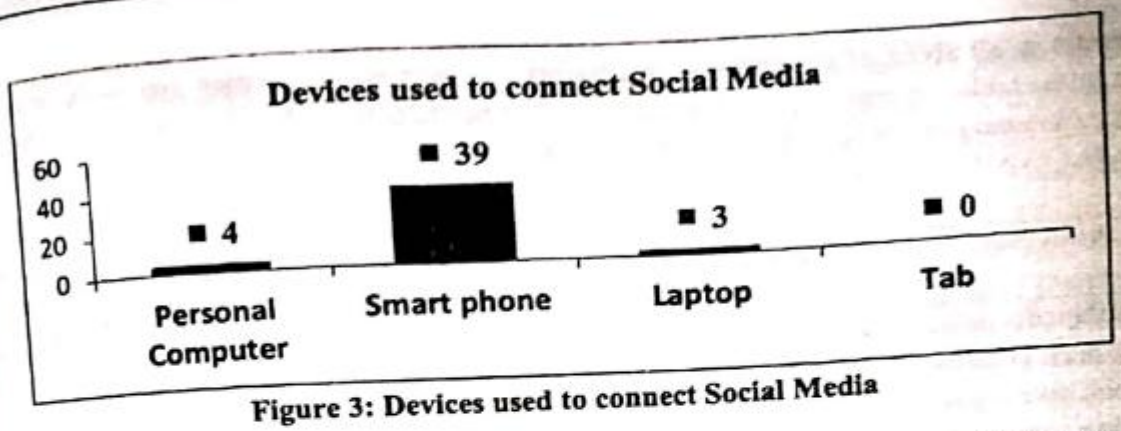

Figure 3: Devices used to connect Social Media

Social media can be accessed by using various electronic devices. The investigator try to know which devices are popularly used by the respondents for accessing social media. The results indicate that majority of the respondents 39 (84.8%) using Smart phones, followed by personal computer 4 (8.7%), laptop 3 (6.5%), no respondent uses Tablets to connect social media.

Table 1: Registered users of social media sites

Social Media	No Respondents	Percentage
Face book	30	65.21
Twitter	5	10.86
YouTube	34	73.91
LinkedIn	0	0
Instagram	15	32.6
Google+	30	65.21

The above table depicts that majority of the respondents (73.91%) are having register or account in you tube followed by face book & Google+ (65.21%).32.6% are having account in Instagram, only 10.86% are in Twitter. It can be concluded that majority of the respondents are having account in YouTube.

Table 2: Frequency of Social Media use in a Day

Gender	Time Spent in using Social media				Total
	less than 1 hour	1-2 hours	2-3 hours	more than 3 hours	
Male	3(13.6%0	14(63.6%)	3(13.6%)	2(9.1%)	22(100%)
Female	5(20.8%)	6(25.0%)	6(25.0%)	7(29.2%)	24(100%)
Total	8(17.4%)	20(43.5%)	9(19.6%)	9(19.6%)	46(100%)

The above data in table 2 reveals that the time spent by the respondents in using social media in a day. The results explains that 20 (43.5%) of the sample admitted that they spent 1-2 hours per day checking social media sites, followed by 9(19.6%)spent more than 2-3 hours and more than three hours each. Only 8(17.4%) opined that they spent less than an hour in using the social media sites in a day.

Table 3: Purpose of Using Social media

Purpose of using Social Media	No Respondents	Percentage
Communication	39	84.79
Entertainment	34	73.91
Learning	32	69.56
Social Iteration	21	45.65

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Social media is all about of communication, sharing, exchanging information and social interaction. The data in the table-3 emphasized that majority of the respondents 39 (84.79%) using social media for communication purpose, followed by 34(73.91%) for entertainment. For learning purpose 32 (69.56%) and only 21 (45.65%) for social interaction.

Table 4: Use of Social media for Academic purpose

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
use of Wikipedia helps a lot in getting back ground information on a topic.	17 (37%)	29 (63%)	0	0	0	46 100%
Information gotten from social networks like Lislinks ,blogs like Lisquiz, , to complement what you have been taught in class.	5 (10.9%)	20 (43.5%)	18 (39.1%)	1 (2.2%)	2 (4.3%)	46 100%
Using face book with lecturers is help full in the outside class hours.	2 (4.3%)	12 (26.1%)	8 (17.4%)	13 (28.3%)	11 (23.9%)	46 100%
Lisforum (NCSI e-mail) postings improve. professional awareness on various aspects.	8 (17.4%)	26 (56.5%)	12 (26.1%)	0	0	46 100%
A profile in LinkedIn helpful to build a professional network.	8 (17.4%)	30 (65.2%)	4 (8.7%)	3 (6.5%)	1 (2.2%)	46 100%
Total	40 (17.39%)	117 (50.86%)	42 (18.26%)	17 (7.39%)	14 (6.06%)	230 100%

The above table shows that 40 (17.39%) of the respondents strongly agree and 117 (50.86%) agree that social media are useful for the academic purpose. 18.26 % of the respondents are undecided the usefulness of social media for their learning. Only a small percentage 7.39% and 6.06% are disagree the usefulness of social media for academic purpose. From the data we found any interesting opinion of the students. Majority of the respondents 28.3% disagree and 23.9% strongly disagree in using face book to connect lecturers to clarify the doubts in the outside class room. We can conclude that students are accepting and using social media for academic purpose.

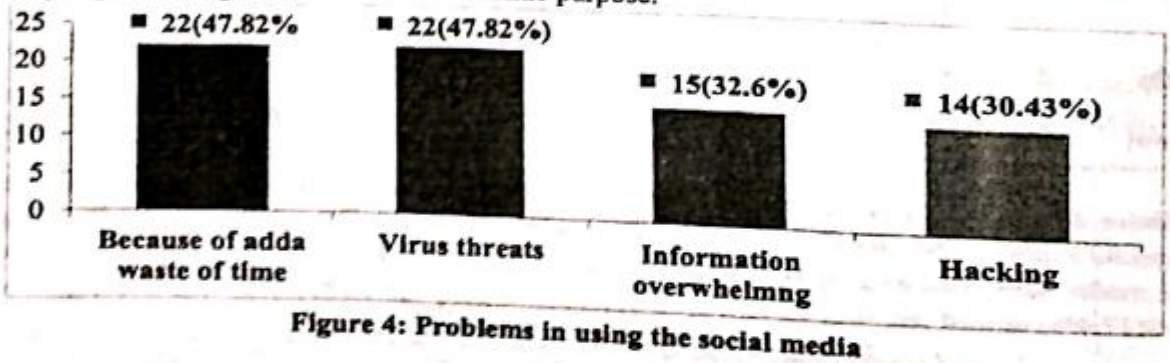

Figure 4: Problems in using the social media

The above fig-4reports that the problems facing by the respondents in using social media. Majority of the respondents 22(47.82%) opined that by using social media they wasting their valuable time because of un necessary advertisements, followed by 22 (47.82%) virus threats, 15 (32.6%) opined that social media is information overwhelming, and 14 (30.43%) is fear of hacking.

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Findings and Conclusion

Majority of the respondents 25 (54.3%) opined that their self-interest is the key factor to aware of social media. Majority of the respondents 39 (84.8%) are using Smart phones for accessing social media. Majority of the respondents (73.91%) are having an account in YouTube. Majority of the respondents 20 (43.5%) spent 1-2 hours per day for using social media. Majority of the respondents 39 (84.79%) using social media for communication purpose. 40 (17.39%) of the respondents strongly agree and 117 (50.86%) agree that social media are useful for the academic purpose. Majority of the respondents 22(47.82%) opined that using social media wasting their valuable time because of un necessary advertisements. After examining the results of the study it can be conclude that MLISc students of Bangalore University using the social media tools for academic purpose. Based on the findings of the study it is to suggest that students should manage their time and prevent distractions provided in social media. The information professionals, librarians and teaching faculty collectively organize information literacy programs and create awareness among the students on the value of information sources in social media and how to evaluate information in such sources.

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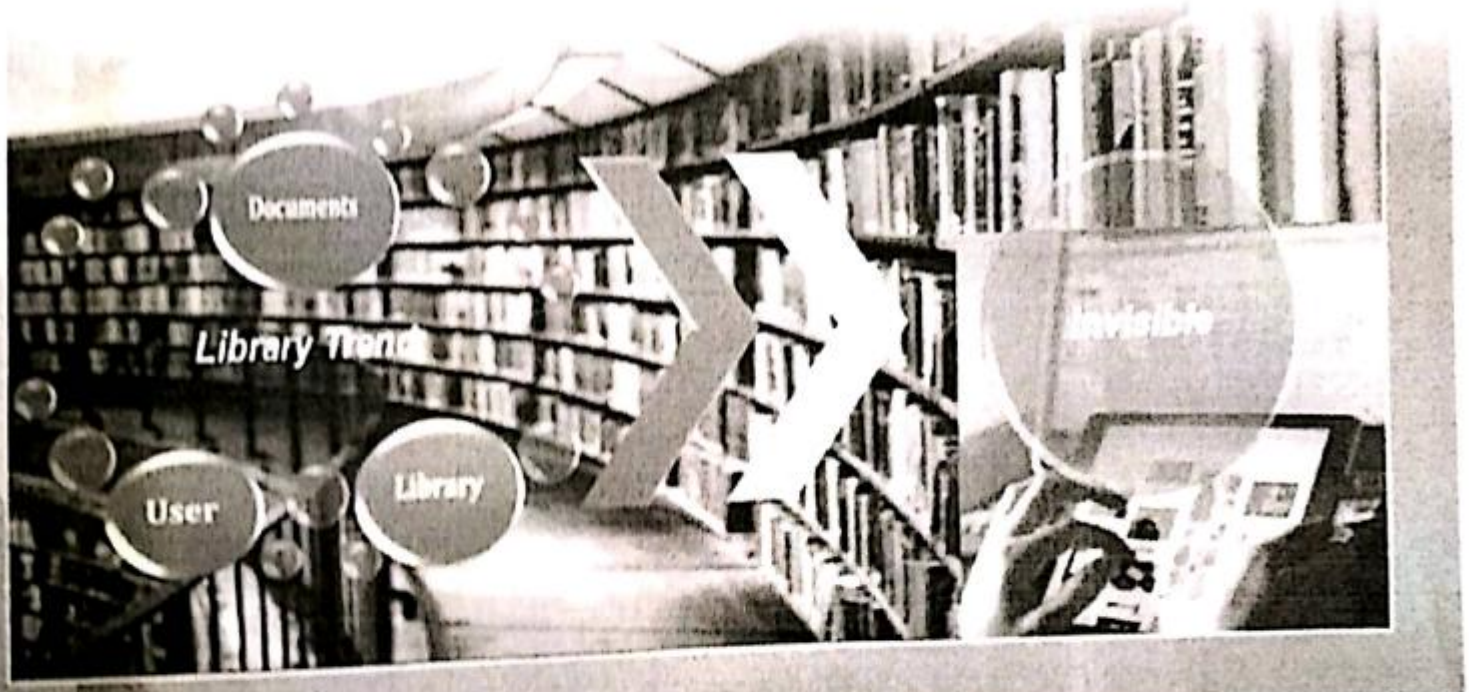

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About Editors

Prof. Keshava obtained Ph.D from Karnatak University, Dharwad. He started his career as lecturer at Karnatak University, Dharwad and presently working as Professor at Tumkur University, Tumakuru. He has 20 years of rich experience in teaching and research. He has published more than 100 research papers in national and international peer-reviewed journals and conference proceedings. He has successfully guided 7 doctoral students for their Ph.D. and 8 students are pursuing research under his guidance. He has acted as resource person in several national and international conferences and chaired many technical sessions. He is a life member of ILA, IATLIS and KALA. He has presented research paper at an international conference held at Bangkok, Thailand. His areas of research interest are Scientometrics and Information Processing and Retrieval.

Mr. Rupesh Kumar A has postgraduate degree in Library and Information Science from Bangalore University and Post graduate Diploma in Library Automation and Networking from Annamalai University. Presently, he is working as Assistant Professor at Department of Studies and Research in Library and Information Science, Tumkur University. He has presented papers in international and national conferences. Some of his papers have won best paper award. His areas of interest are library automation, digital libraries, and webometrics.

Mr. M N N Prasad is Selection Grade Librarian at Government First Grade College, Tumakuru. He is the President of Karnataka State College Librarians Association (KSCLA). He has 32 years of rich experience in designing and delivering information services. He has published several articles in reputed journals and conference proceedings. Under his leadership, KSCLA has organized many professional development programmes such as conferences, seminars and training programmes.

About Organizers

Department of Studies and Research in Library and Information Science, Tumkur University :

The Department was established in 2005 with the objective of imparting high quality education in Library and Information Science with competence in meeting the challenges of the knowledge society. The Department has a well-equipped computer lab, information processing tools and well-qualified faculty members with rich academic, industrial and corporate experience. The faculty members have successfully carried out major and minor research projects funded by UGC and ICSSR. They are actively engaged in publishing papers in reputed international and national journals and conferences and have won several best paper awards. In the past six years, the Department has organized one international and three national conferences. "Saturday Mirror" special Lecture series is a unique initiative of the Department.

Karnataka State College Librarians Association (KSCLA):

The association was established in 1979 with the objective of improving the services of college libraries, the status and service conditions of library staff, co-operating actively to benefit mutually by the resources available in the libraries, strengthening the financial resources of college libraries and raising the professional standard of library staff in college libraries. During the span of four decades, significant achievements have been made for the cause of librarianship in Karnataka State to develop the college libraries. Professor T S Rubin was the first President of KSCLA. At present, Sri. M N N Prasad is the President. The Association has organized several national level conferences and seminars in association with universities and colleges in different parts of Karnataka.

Alumni Association of Library and Information Science of Tumkur University (AALISTU):

Alumni Association of Library and Information Science of Tumkur University (AALISTU) came into existence on 16th December, 2017 with an objective to encourage the active and positive participation of alumni. It is actively functioning with its pre-defined objective to act as a platform for the alumni to create and maintain a life-long connection with the Department by organizing conferences, seminars, workshops and also through invited talks. The alumni is assisting in the strategy and planning of curriculum development and also acts as a bridge across batches, developing valued services for classmates and friends and giving a helping hand to current students.

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Cattaneo-Christovheat flux on hydromagnetic and chemically reacting nanofluid flow across a stretching sheet

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ABSTRACT

The aim of present article is to inspectthe consequences of chemical reaction on magnetohydrodynamicCasssonCarreau-Yasuda andWilliamson Nanofluid flow over a nonlinear widening sheetby oonsideringJouleheating,velocity slip and convective boundary conditions.The Cattaneo – Christov heat flux model is imposed in the energy equation. Comparability changes are used to change over overseeing incomplete differential equations into nonlinear ordinary differentialequations. Numerical strategy i.e shooting method is accomplished to register the outcomes.The effects of physical parameters like Weissenberg number, velocity slip parameter, Thermophoresis number, Nonlinear extending parameter, Attractive field parameter, Lewis number, Brownian movement parameter, Prandtl number, Eckert number, Concoction response parameter, Warm Biot number, Focus Biot number, Casson parameter on velocity, temperature and fixation profiles are considered with the guide of plots. Likewise the physical amounts,

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for example, skin grinding coefficient, the neighborhood Nusselt number and the Sherwood number are analyzed with the assistance of plots and tables.

Keywords: Carreau-Yasudananofluid,Williamsonnanofluid, Chemical reaction parameter, MHD, Jouleheating, Casson fluid, Velocity slip,Convective conditions.

1. INTRODUCTION

Over the modern-day couple of decades, the prevalentmainstream of the masters and scientist round the world consistently endeavored to overcome ingenious facets of nanotechnology. Choi[1] portrayed the hypothetical notion of nanofluid through suspending metallic nanoparticles in predictable heat transfer fluids. Kuznetsov and Nield [2] have said about the commonplace convective boundary layer flow of a nanofluid beyond a vertical plate severely. They utilized a method where Brownian movement and thermophoresis affects have been taken into consideration.Ahmadi and Willing[3] considered the effect of glide rate, go with the flow performance, and particle absorption on the heat transfer coefficient of a CuO/water nanofluid both tentatively and hypothetically. Gnaneswara Reddy et al.[4] have investigated about theimpact of magnetic field on viscous flow of a nanofluid. They clinched the rate of heat transfer on non-linear stretching sheet scale back with increment in magnetic field parameter.A fluid which does no longer comply with Newtonian's law is known as non-Newtonian fluid (Casson fluid). Casson fluid mannequin for viscoelastic fluid flow was created byCasson in 1995. Pranamanik[5] examined limit layer stream of a Casson liquid over an exponentially streching sheet. Consolidated impacts of suction and thermal liquids are

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investigated.Gnaneswara Reddy et al. [6] obtained numerical solution for the boundary layer flow, heat and mass transmission nanofluid over a chamber with first order pace and convective situations via using the fourth-order Runge-Kutta integration scheme along taking pictures technique.Dash et al. [7] tested the behavior of Casson fluid below yield stress via a homogeneous permeable medium bounded through round tube.Mustafa and Khan [8] investigated the magnetic field impact in Casson nanofluid over a nonlinearly stretching sheet. MHD is the investigation of electrically directing fluids, joining the two standards of liquid elements and electromagnetism.Ganesan et al. [9] have researched precarious normal convection MHD stream past an inclined plate with variable surface warmth and mass transition. Jafar et al. [10] analyzed MHD float and heat transfer over extending/contracting sheets with outer magnetic field, viscous dissipation and Joule heating impacts. Ishak [11] proposed instable MHD flow and heat transfer in stretching plate. Gnaneswara Reddy and Bhaskar Reddy[12] analyzed the radiation mass transfer impacts on the MHD flow of the fluid upon a moving cylinder.

Mamatha et al.[13] investigated Cattaneo-Christov heat flux on unsteady dusty nano Eyring-Powell fluid over a sheet with heat and mass flux conditions. Zubair et al.[14] examined nonlinear convective flow of thixotropic fluid via an exponentially stretched surface. Dogonchi and Ganji [15] investigated the outcome of Cattaneo–Christov warm transition show on the shaky squeezing MHD nanofluid stream and heat exchange between two parallel plates considering thermal radiation influence.RamReddy et al.[16] have considered the combined effects of Joule heating

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and Hall effect on the free convection flow of an electrically directing Casson fluid in a vertical divert within the sight of viscous dissipation. Masood Khan et al.[17] reported the impacts of the MHD Carreau fluid in inertia factor flow with unending shear rate viscosity. In addition, Joule heating and nonlinear radiative heat exchange is analyzed inside seeing convective boundary condition.Hayat et al.[18] noticed that liquefying parameter enhancements the velocity and diminishes the temperature field. Temperature profile increments when extent division of copper nanoparticles is expanded.

The significance of non-Newtonian fluids in a massive element of the physiological and contemporary approaches is very self-evident. The single constitutive condition appears to be deficient to comprehend the viscoelastic behavior of such fluids. This failure prompts the recommendation of a few models for the non-Newtonian fluids. TheCarreau–Yasuda fluid mannequin isthe oneout of potential to anticipate the rheological behavior of such fluids thru shear thickening/diminishing parameters. Despite the speed of this fluid model, simply the few researches have been made in the past attributable to Carreau–Yasuda fluid[19,20]. Mair Khan et al.[21] analyzed magnetohydrodynamic (MHD) flow of .Carreau-Yasuda nanofluid subsequent to a non-linearly extending sheet under slip, convective and zero typical flux stipulations with joule heating and chemical reaction. Salahuddin et al. [22] reviewed the numerical examination of MHD flow of Williamson fluid mannequin over a sheet with flexible thickness. Cattaneo-Christov heat flow exhibit a modified kind of Fourier's law is

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employed to check out the heat transfer phenomena.Malik et al.[23] explored the Williamson fluid over a starching cylinder with consolidated influences of variable thermal conductivity and heat generation/retention.Krishnamurthy et al.[24] examined the nanoparticles investigation for the Williamson fluid model. Nadeem and Hussain[25] have scrutinized the numerical solution of the two-dimensional flow of Williamson nanofluid over a stretching sheet.

The objective of the present work is to compute numerical solution for the margin layer flowof Cattaneo-Christov MHD CassonCarreau-Yasuda and Williamson nanofluidover widening sheet with chemical reaction, Joule heating by considering first ordervelocity slip and convective boundary circumstances. R-K fourth order strategy alongside shooting technique was used for concentrate the impacts of imperative physical parameters like the first order velocity slip parameter, thermal Biot number, Concentration Biot number, Prandtl number, Eckert number on velocity, temperature supply, Nano particle fixation, skin friction coefficient, warmth and mass exchange rates with the assistance of plots and tables.The present problem is the extension work of Miar Khan et al. [21] extended for Casson and Cettanio-Cristov nanofluid with first order velocity slip and convective boundary conditions.

2. MATHEMATICAL FORMULATION

Asteady two-dimensional laminar incompressible boundary layer flow of aCattaneo-ChirstovMHD CassonCarreau-Yasuda nanofluid flowing upon a stretching foil under

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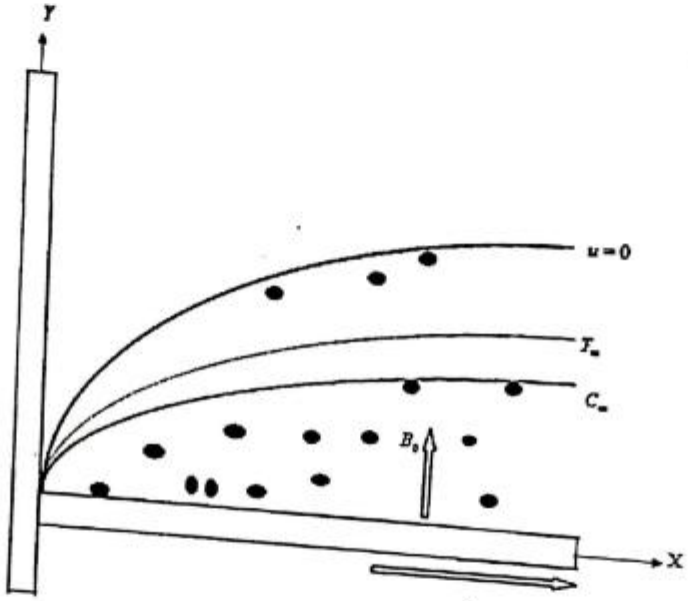
zero normal flux, slip and convective conditions are taken. The flow is not restricted to $y < 0$ and employed y along vertical to the stretching plate.

Constitutive equation of Carreau-Yasuda fluid is:

$$\tau = \left[\mu_\infty + (\mu_0 - \mu_\infty)\left(1 + \left(\Gamma \dot{\gamma}\right)^a\right)^{\frac{n-1}{a}}\right] A_1 \quad (1)$$



$$-\kappa \frac{\partial T}{\partial y} = h_f (T_w - T),\ D_B \frac{\partial C}{\partial y} + \frac{D_T}{T_\infty} \frac{\partial T}{\partial y} = 0$$

Fig.1. Schematic diagram

μ_0 is zero shear rate viscosity, A_1 is first Rivlin-Ericksen tensor, τ is extra stress tensor and $\dot{\gamma}$ is represented by $\dot{\gamma} = \sqrt{\frac{1}{2} tr\left(A_1^2\right)}$, here $A_1 = [\text{gradV} + (\text{gradV})^T]$. It is assumed that infinite shear rate viscosity $\mu_\infty = 0$ and the Equation (1) takes the following form

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$$\tau = \left[\mu_0\left(1+\left(\Gamma\dot{\gamma}\right)^d\right)^{\frac{n-1}{d}}\right]A_1 \quad (2)$$

velocity profile for existing flow situation is specified by $V=\left[u(x,y),v(x,y),0\right]$, the temperature distribution $T=T(x,y)$ and the nanoparticle concentration $C=C(x,y)$. The governing equations of the fluid flow can be written as:

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0 \quad (3)$$

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=\upsilon\left(1+\frac{1}{\beta}\right)\frac{\partial^2 u}{\partial y^2}+\Gamma^d\left(\frac{n-1}{d}\right)(d+1)\frac{\partial^2 u}{\partial y^2}\left(\frac{\partial u}{\partial y}\right)^d\upsilon-\frac{\sigma B_0^2 u}{\rho} \quad (4)$$

$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\alpha\frac{\partial^2 T}{\partial y^2}+\tau\left[\left(\frac{D_T}{T_\infty}\right)\left(\frac{\partial T}{\partial y}\right)^2+D_B\left(\frac{\partial T}{\partial y}\right)\left(\frac{\partial C}{\partial y}\right)\right]$$
$$+\frac{\sigma B_0^2 u^2}{\rho c_p}-\lambda\left[u\frac{\partial u}{\partial x}\frac{\partial T}{\partial x}+v\frac{\partial v}{\partial y}\frac{\partial T}{\partial y}+u\frac{\partial v}{\partial x}\frac{\partial T}{\partial y}+v\frac{\partial u}{\partial y}\frac{\partial T}{\partial x}+2uv\frac{\partial^2 T}{\partial x\partial y}+u^2\frac{\partial^2 T}{\partial x^2}+v^2\frac{\partial^2 T}{\partial y^2}\right] \quad (5)$$

$$u\frac{\partial C}{\partial x}+v\frac{\partial C}{\partial y}=D_B\left(\frac{\partial^2 C}{\partial y^2}\right)+\left(\frac{\partial^2 T}{\partial y^2}\right)\left(\frac{D_T}{T_\infty}\right)-K_0(C-C_\infty) \quad (6)$$

where ρ is the density of base fluid, σ is electrical conductivity, u and v are the velocity mechanisms in x and y directions respectively, B_0 is magnetic field strength, T is the fluid temperature, υ is the kinematic viscosity, $\alpha=\frac{k}{\rho c_p}$ is thermal diffusivity, $\tau=\frac{(\rho c)_p}{(\rho c)_f}$ is the ratio midst the definite heat ability of nanoparticle to the base fluid, D_B is measurement of Brownian motion while D_T denotes measurement of thermophoresis distribution, Here C represents nanoparticle immersion. The wall temperature and nanoparticle concentration are indicated as T_∞ and C_∞.

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The rheological equation of state for an isotropic and incompressible movement of a Casson fluid can be expressed as follows:

$$\tau_{ij}=\begin{cases}2\left(\mu_B+P_y/\sqrt{2\pi}\right)e_{ij}, & \pi>\pi_c\\ 2\left(\mu_B+P_y/\sqrt{2\pi}\right)e_{ij}, & \pi<\pi_c\end{cases}$$

Here μ_B is the plastic energeticthickness of the non-Newtonian fluid, P_y is the yield stress of fluid, π is the result of the element of distortion rate of (i,j) the component and $\pi=e_{ij}e_{ij}$, π_c is the critical value of π grounded on non-Newtonian model. $\beta=\mu_B\sqrt{2\pi_c}/p_y$ is the Casson fluid parameter,When y goes to infinity, the corresponding standards of temperature and nanoparticle concentration are indicated by T_∞ and C_∞ respectively, C_p is specific heat and K_0 is chemical reaction coefficient.

With boundary conditions:

$$u=cx^n+g\left(\mu_B+\frac{p_y}{\sqrt{2\pi_c}}\right)\frac{\partial u}{\partial y},\ v=0,$$

$$-k\left(\frac{\partial T}{\partial y}\right)=(h_f)(T_w-T),D_B\frac{\partial C}{\partial y}+\frac{D_T}{T_\infty}\frac{\partial T}{\partial y}=0,\ at\ y=0,\ u\to 0,C\to C_\infty,T\to T_\infty\ as\ y\to\infty$$

(7) where T is temperature, bottom surface of plate is excited by convection at temperature T_f which gives heat transmission constant h_f, T_w is uniform temperature of sheet and k is the thermal conductivity.

Define followingtransformations as

$$\left.\begin{aligned}&\eta=y\sqrt{\frac{c(n+1)}{2\upsilon}}x^{\frac{n-1}{2}},\ u=cx^nf'(\eta),\\ &v=-x^{\frac{n-1}{2}}\left(f'(\eta)\frac{n-1}{n+1}\eta+f(\eta)\right)\sqrt{c\upsilon\left(\frac{n+1}{2}\right)}\\ &\phi(\eta)=\frac{C-C_\infty}{C_w-C_\infty},\ \theta(\eta)=\frac{T-T_\infty}{T_w-T_\infty}\end{aligned}\right\}(8)$$

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By employing equations(8) into equations (3-6) along the boundary conditions (7) the reduced governing equations are

$$f'''\left[\left(1+\frac{1}{\beta}\right)+(f'')^{d}\left(\frac{n-1}{d}\right)(d+1)(We)^{d}\right]-(f')^{2}\frac{2n}{n+1}+ff''-Mf'=0 \quad (9)$$

$$\theta''+\Pr\theta' f+\Pr Nb\phi'\theta'+\Pr Nt(\theta')^{2}+M\Pr(Ec)(f')^{2} - \Pr a_1\left(ff'\theta'+f^{2}\theta''\right)=0 \quad (10)$$

$$\phi''+\frac{Nt}{Nb}\theta''+\Pr Lef\phi'-\Pr Le\gamma\phi=0 \quad (11)$$

The related boundary conditions are

$$\left.\begin{aligned} &f=0,\ f'=1+\alpha_1\left(1+\frac{1}{\beta}\right)f'',\ \theta'=-\mathrm{Bi}_1(1-\theta),\ \phi'=-\mathrm{Bi}_2(1-\phi)=0,\ at\ \eta=0\\ &f'\to 0,\quad \theta\to 0,\quad \phi\to 0\ as\ \eta\to\infty \end{aligned}\right\} \quad (12)$$

Here $We=c\Gamma\sqrt{\frac{c(n+1)}{2\upsilon}}X^{\frac{3n-1}{2}}$ is the Weissenberg number, $M=\frac{2\sigma B_0^2}{(n+1)\rho cx^{n-1}}$ is the magnetic field parameter, $Nt=\frac{(T_w-T_\infty)}{T_\infty\upsilon}$ is thermophoresis diffusion, $Nb=\frac{(C_w-C_\infty)D_B\tau}{\upsilon}$ is Brownian motion parameter, $\Pr=\frac{c_p\mu}{k}$ is Prandtl number, $Le=\frac{\alpha}{D_B}$ is Lewis number, $Ec=\frac{c^2x^{2n}}{(T_w-T_\infty)c_p}$ is Eckert number and $\gamma=\frac{2K_0}{c(n+1)\left(x^{n-1}\right)}$ is chemical reaction parameter, Casson fluid parameter β, $a_1=\lambda\left(\frac{n+1}{2}\right)cx^{n-1}$ is the thermal relaxation parameter, $\alpha_1=g\sqrt{\frac{c(n+1)}{2\upsilon}}x^{\frac{n-1}{2}}$ is first order velocity slip parameter, $\mathrm{Bi}_1=\frac{h_f}{k}\frac{R}{r}\sqrt{\frac{l\upsilon_f}{a}}$ is the thermal Biot number, $\mathrm{Bi}_2=\frac{k_m}{D_m}\frac{R}{r}\sqrt{\frac{l\upsilon_f}{a}}$ is the concentration Biot number.

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The proposed problem shows two diverse fluids built on the following assumptions,

1. Consider $n=2, d=1$ in the momentum equation, this shows the flows of Williamson fluid.

2. Consider $n \neq 2, d \neq 1$ in the momentum equation, this shows the flow of Carreau-Yasuda fluid.

The quantity such as coefficient of friction factor, rate of heat and mass transfer are interpreted as:

$$C_f = \frac{\tau_w}{\rho u^2}, \quad Nu_x = \frac{q_w x}{k(T_w - T_\infty)}, \quad Sh_x = \frac{x q_m}{D_B(C_w - C_\infty)} \tag{13}$$

In which τ_w, q_w and q_m represents shear stress, mass flux and heat flux at the surface of sheet. These quantities are defined as:

$$\tau_w = \mu_0\left(1+\Gamma^d\left(\frac{n-1}{d}\right)\left(\frac{\partial u}{\partial y}\right)^d\right)\left(\frac{\partial u}{\partial y}\right)_{y=0}, \quad q_w = -\left(\frac{\partial T}{\partial y}\right)_{y=0} \quad q_m = -\left(\frac{\partial C}{\partial y}\right)_{y=0} \tag{14}$$

Substitution of equation (14) intoequation (13)skin friction coefficient, local Nusselt and Sherwood numbers are:

$$\left.\begin{aligned} C_f \,\mathrm{Re}_x^{1/2} &= f''(0)\sqrt{\frac{n+1}{2}}\left(1+\left(\frac{n-1}{d}\right)(f'')^d (We)^d\right), \\ Nu_x \,\mathrm{Re}_x^{-\frac{1}{2}} &= -\sqrt{\frac{n+1}{2}}\theta'(0), \\ Sh_x \,\mathrm{Re}_x^{-\frac{1}{2}} &= -\sqrt{\frac{n+1}{2}}\phi'(0) \end{aligned}\right\} \tag{15}$$

where $\mathrm{Re}_x = \frac{ux}{\upsilon}$ is the Reynolds number.

3. NUMERICAL SOLUTION

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The nonlinear momentum, energy and concentration equations (9-11) along with the boundary conditions (12) forms highly non-linear coupled ODE's. To solve these coupled nonlinear differential equations, we implemented R-K shooting technique. For these we consider

$$f = y_1,\ f' = y_2,\ f'' = y_3$$

$$f''' = \frac{1}{\left[\left(1+\frac{1}{\beta}\right)+(y_3)^d\left(\frac{n-1}{d}\right)(d+1)(We)^d\right]}\left[y_2^2\left(\frac{2n}{n+1}\right)-(y_1)(y_3)+(y_2)M\right] \quad (16)$$

$$\theta = y_4,\ \theta' = y_5$$

$$\theta'' = \frac{1}{\Pr a_1 y_1^2 - 1}\left[\begin{matrix}\Pr y_5 y_1 + y_5 y_7 \Pr Nb + (y_5)^2 \Pr Nt + M \Pr Ec (y_2)^2 \\ -\Pr a_1 y_1 y_2 y_5\end{matrix}\right] \quad (17)$$

$$\phi = y_6,\ \phi' = y_7,\quad \phi'' = -\frac{Nt}{Nb}\theta'' - \Pr Le y_1 y_7 + \Pr Le\gamma y_6$$

(18)

with the corresponding boundary conditions

$$y_1 = 0,\quad y_2 = 1+\alpha_1\left(1+\frac{1}{\beta}\right)y_3,\ y_5 = -Bi_1(1-y_4),\ y_7 = -Bi_2(1-y_2) \text{ at } \eta = 0 \quad (19)$$

$$y_2 \to 0,\ y_4 \to 0,\ y_6 \to 0 \text{ as } \eta \to \infty$$

To explain the Equations (16)- (18), we guess the values of y_3, y_5 and y_7 which are not given at the initial conditions. Once all preliminary conditions are found then we solve theequations(16)- (18) are integrated by using Runge-Kutta fourth order method with the successive iterative step length is 0.01.

4. RESULTS AND DISCUSSION

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This study analyzes the influences of the important physical parameters ondimensionless velocity, temperature and non-dimensional concentration profileswith the help of the graphs and tables. To obtain the preferred accuracy we have compared our result with previously published results by Gnaneswara Reddy et al. (6), Mustafa and Khan (8). Our results agreed with the previous result as illustrated in table 1 and table 2. The default values are taken for Numerical computation.

$M = Ec = 0.5,\ \alpha_1 = Bi_1 = Bi_2 = \beta = Nt = Nb = a_1 = 0.1, We = 1.0, \Pr = 3, n = 2, d = 1$

Table 1: Comparison of values of skin friction coefficient $-f''(0)$ with previous results when $\Pr = \alpha_1 = Bi_1 = Ec = Bi_2 = M = Nt = a_1 = We = 0, Nb = 0.000001, n = 2, d = 1$

β	Gnaneswara Reddy et al. [6],	Mustafa and Khan [8]	Present result
0.5	0.481283	0.479891	0.481281
1.o	0.582274	0.559686	0.584874
5.0	0.753164	0.733257	0.753256

Table 2: Comparison of values of skin friction coefficient $-f''(0)$ with previous results when $\Pr = \alpha_1 = Bi_1 = Ec = Bi_2 = M = Nt = a_1 = We = n = d = 0, Nb = 0.000001$

β	Gnaneswara Reddy et al.	M. Mustafa and J. A. Khan[8]	Present result

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	[6]		
0.5	0.481283	0.479891	0.481581
1.0	0.582274	0.559686	0.584972
5.0	0.753164	0.733257	0.753257

The varieties of skin friction coefficient, Nusselt number and Sherwood number with Eckert number, Prandtl number, first-order velocity slip parameter, Thermophoresis parameter, unwinding time parameter, Brownian movement parameter, thermal Biot number, fixation Biot number, non-Newtonian fluid parameter and Casson parameter are appeared in Table 3 for Carreau-Yasuda and Table 4 for Williamson fluids.It is experimental that for Carreau-Yasuda and Williamson fluids skin friction coefficient is amplified for magnetic parameter, Casson parameter, Eckert number, relaxation parameter, Prandtl number,concentration Biot number.

Table3: Computed values for skin friction coefficient, Nusselt number and Sherwood number for various values of the important governing parameters of Carreau–Yasuda fluids.

M	β	Ec	a_1	Pr	Bi_1	α_1	Bi_2	Nt	Nb	$-f''(0)$	$-\theta'(0)$	$-\phi'(0)$
0.5										0.28825	0.12003	0.18205
1.0										0.29950	0.12838	0.18305
1.5										0.30012	0.15986	0.18330
	0.									0.5547	0.11233	0.18386

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	1.0									0.60807	0.10125	0.18386
	1.5									0.62814	0.09872	0.18386
		1.0								0.32224	0.05098	0.20508
		1.5								0.38148	0.10875	0.20508
		1.8								0.40108	0.15605	0.20509
			0.5							0.19375	0.10004	0.18365
			0.8							0.19375	0.09874	0.18365
			1.2							0.19375	0.08892	0.18366
				0.6						0.27375	0.15783	0.20243
				0.7						0.28375	0.16807	0.30156
				0.8						0.30001	0.18880	0.35128
					0.3					0.28825	0.12003	0.18205
					0.5					0.28825	0.11004	0.15682

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					1.0					0.2882 5	0.10006	0.10029
						0. 5				0.6325 5	0.19307	0.57137
						1.0				0.63100	0.20001	0.57148
						1.5				0.6300 0	0.21506	0.58100
							0.0 9			0.2882 9	0.12138	0.18305
							0.5			0.2883 0	0.11003	0.17306
							1.0			0.28831	0.10004	0.15007
								1.0		0.6295 3	0.2004 3	0.5479 2
								1.5		0.61000	0.18894	0.5500 8
								2. 0		0.60001	0.16800	0.58001
									0.5	0.64651	0.15792	0.5980 8
									0.9	0.64651	0.16892	0.51234
									1.5	0.64651	0.20081	0.50123

While a shift result is found for first order velocity slip parameter, thermophoresis parameter. Nusselt number is likewise expanded for attractive parameter, Eckert number, Prandtl number, speed slip parameter, Brownian movement parameter and for Casson parameter, while a switch conduct is seen on account of unwinding parameter,

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thermophoresis parameter, thermal and focus Biot numbersSherwood number expanded for attractive parameter, Eckert number, Prandtl number, speed parameter, thermophoresis parameter, unwinding parameter while it is diminished for Brownian movement parameter, warm and fixation biotnumbers. **Table4:**Computed values for skin friction coefficient, Nusselt number and Sherwood number for various values of the important governing parameters of Williamson fluids.

M	β	Ec	α_1	Pr	Bi_1	α_1	Bi_2	Nt	Nb	$-f''(0)$	$-\theta'(0)$	$-\phi'(0)$
0.5										0.28826	0.12004	0.18206
1.0										0.29951	0.12839	0.18306
1.5										0.30013	0.15987	0.18331
	0.8									0.55479	0.11234	0.18387
	1.0									0.60808	0.10126	0.18387
	1.5									0.62815	0.09873	0.18387
		1.0								0.32225	0.05099	0.20509
		1.5								0.38149	0.10876	0.20509
		1.8								0.40109	0.15606	0.20510
			0.5							0.19376	0.10005	0.18366
			0.							0.19376	0.0987	0.18366

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			8								5	
			1.2							0.19376	0.08893	0.18367
				0.6						0.27376	0.15784	0.20244
				0.7						0.28376	0.16808	0.30157
				0.8						0.30002	0.18881	0.35129
					0.3					0.28826	0.12004	0.18206
					0.5					0.28826	0.11005	0.15683
					1.0					0.28826	0.10007	0.1009
						0.5				0.63256	0.19308	0.57138
						1.0				0.63101	0.20002	0.57149
						1.5				0.63001	0.21507	0.58101
							0.09			0.28831	0.12139	0.18306
							0.5			0.28831	0.11004	0.17307
							1.0			0.28832	0.10005	0.15008
								1.0		0.62954	0.20044	0.54807

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								1.5		0.61001	0.18895	0.55023
								2.0		0.60002	0.16801	0.58016
									0.5	0.64652	0.15793	0.59823
									0.9	0.64652	0.16893	0.51249
									1.5	0.64652	0.20082	0.50138

The following figures (Fig.2 – Fig.25) illustrate contrasts between Carreau-Yasuda and Williamson fluids for various parameters. Fig.2 represents the velocity portrait for magnetic parameter. As increase in the magnetic parameter values the velocity profile decreases. The Fig.3 reflects the velocity portrait for Casson fluid parameter. Casson fluid is a shear thinning liquid which is assumed to have an countless viscosity at 0 rate of shear.So, the velocity of Casson is reduced the growing values of Casson fluid parameter. Fig.4 represents the effects of Eckert number on velocity profile, for increasing the values of Eckert number the velocity profile is decreased. Fig.5 depicts the effect of thermophoresis parameter on velocity profile.As thermophoresis parameter increase the velocityprofile is increased. Fig.6 represents the effect of Weissenberg number on the velocity profile,for increasing values of Weissenberg number the velocity profile increased. Fig.7 exhibits the relation between

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the magnetic parameter and the temperature profile, for increasing values of the magnetic parameter temperature profile is also decreased. Fig.8 indicates the thermal relaxation parameter; in this plot we observed the growing value of thermal relaxation parameter represent the growing temperature profile. Temperature overshoot are noted with an increment of thermal relaxation parameter. The physical cause for such an end result is that as we compare the values of a_1 fluid particles exhibit non conducting behavior due to which they require greater time to convey the heat to their surrounding particles.Fig.9 shows the effects of the first order velocity slip parameter on temperature profile; this portrait represents the decreasing in the temperature profile as increment in the first order velocity slip parameter. Fig.10 reveals effects of the thermal Biot range on temperature profile which indicates the warmth conduction inside the frame is plenty faster than the heat convection far from its floor and the temperature gradient is improved on the surface. So, the temperature values are growing, and then the profile of temperature is also improved. Fig.11 indicates the results of concentration Biot number on temperature profile;with the increase in values of concentration Biot number temperature profile is also improved.Fig.12. shows theoutcomes of Casson fluid parameter on temperature profile.With the diminishing the values of Cassion fluid parameterdiminishing in temperature profile is observed.Fig.13 represent effects of Eckert number on temperature profile; by increasing the values of Eckert number the temperature profile is decreased. Fig.14represents the outcomes of Brownian motion parameter on temperature profile; by improving the values of Brownian motion

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parameter temperature profile is decreased. Fig.15 specifies the influence of thermophoresis parameter on temperature portrait. For growing values of thermophoresis parameter, increment in temperature profile is observed. Fig.16 represents for growing values of Prandtl number, temperature profile decreased. Fig.17 reflects the outcome of Weissenberg number is inversely proportional to the temperature profile. Fig.18 indicates the effect of thermal Biot number on concentration profile. Here thermal Biot number is directly proportional to concentration profile. Fig.19 represents the outcome of concentration Biot number on concentration profile. With theincrement in the values of concentration Biotnumber, concentration profile is diminished. Fig.20 indicates outcome of chemical reaction parameter on concentration profile. For increasing values of chemical reaction parameter, concentration profile is also increased. Fig.21 representseffect of the thermophoresis parameter on concentration profile. For growing values of parameter, concentration profile is decreased.Fig.22 represents impacts of the Brownian motion parameter on concentration profile. The concentration profile is increased for growing value of Brownian motion parameter. Fig.23 The outcome of Prandtl number on concentration profile, with the increase in Prandtl number, there is decrease in concentration profile. Fig.24 represents the skin friction coefficient is decreased when increasing the values of magnetic parameter. Fig.25 represents the Nusselt number is increased when increasing the values of Brownian motion parameter.

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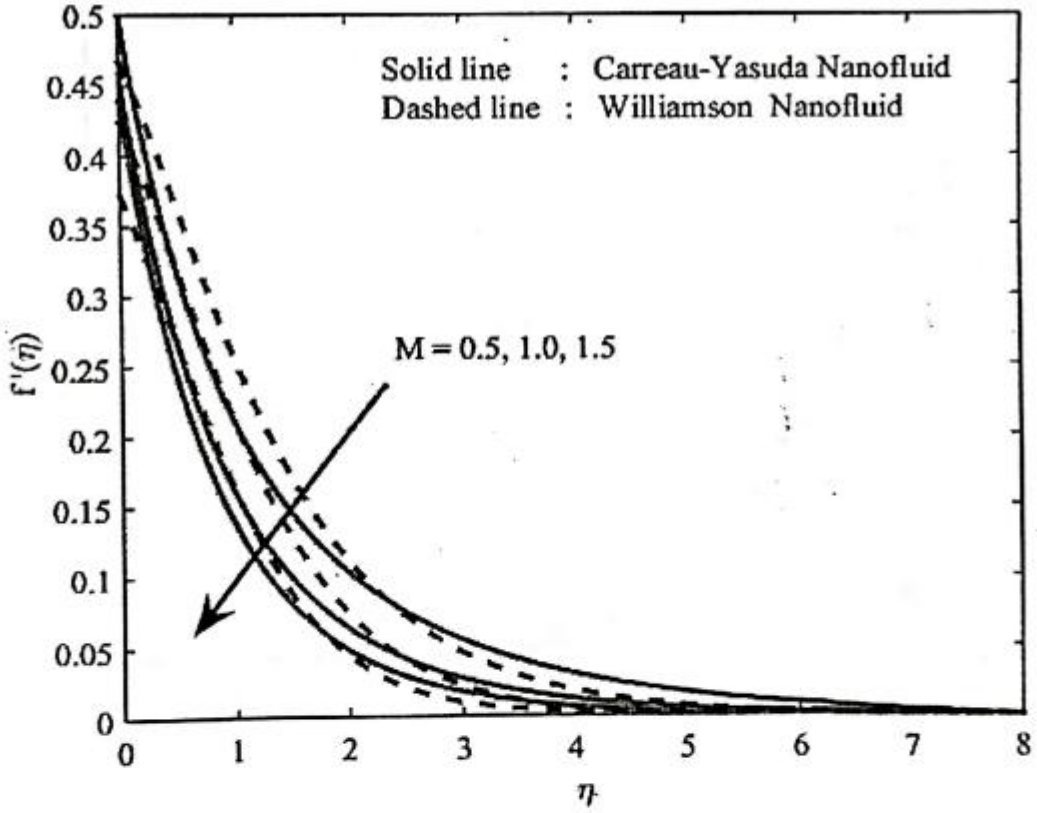

Fig. 2 Influence of M on velocity profile.

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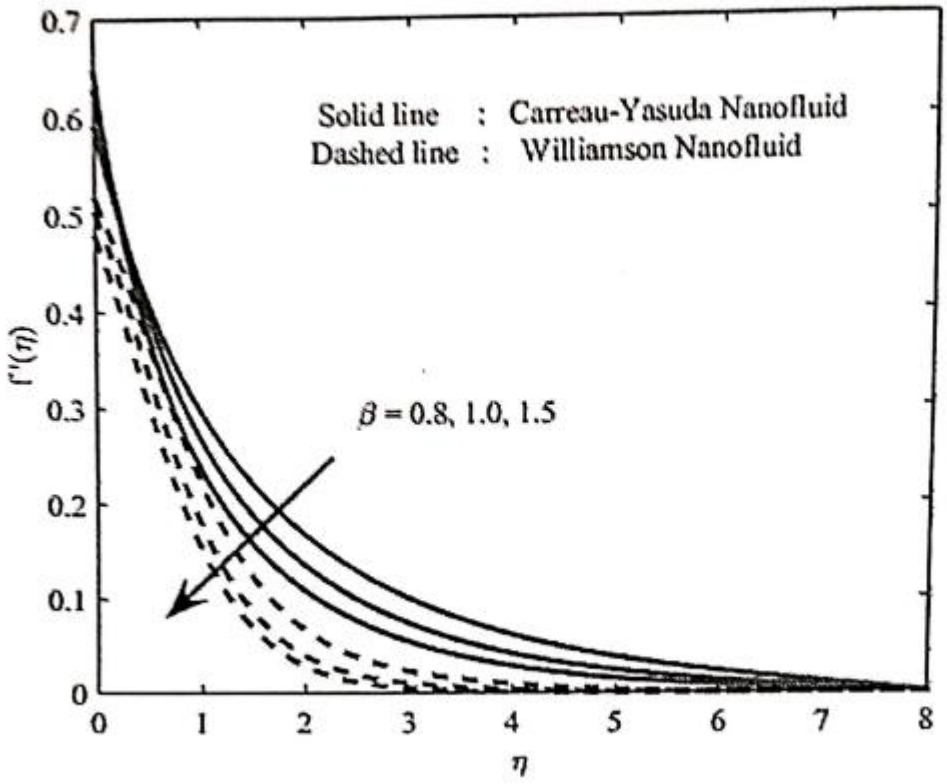

Fig. 3 Influence of β on velocity profile.

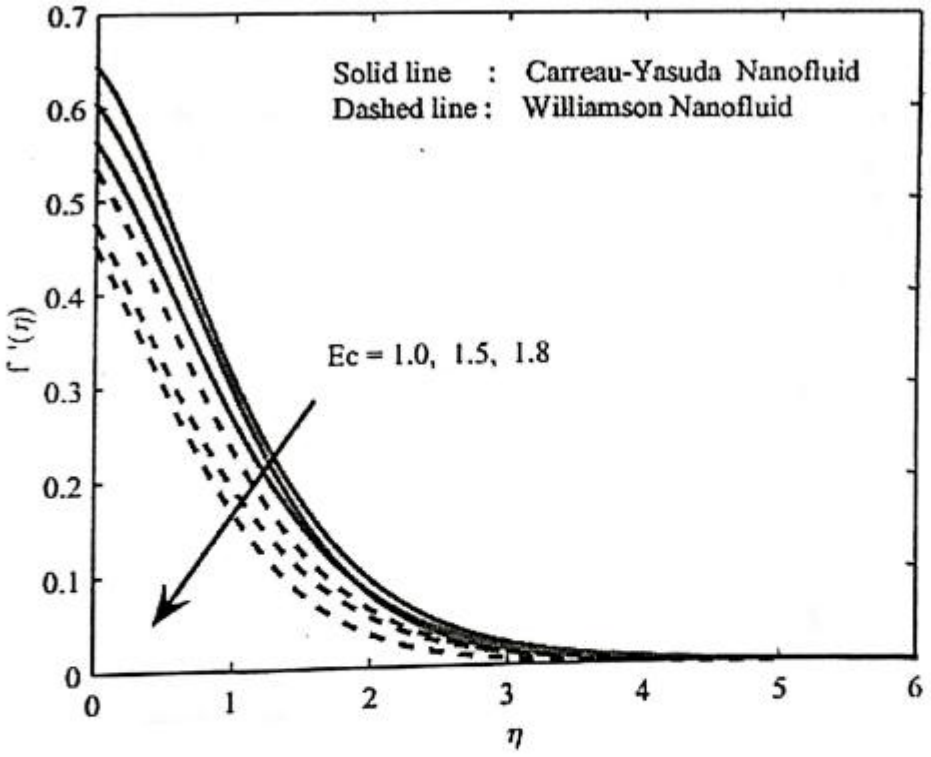

Fig. 4 Influence of Ec on velocity profile.

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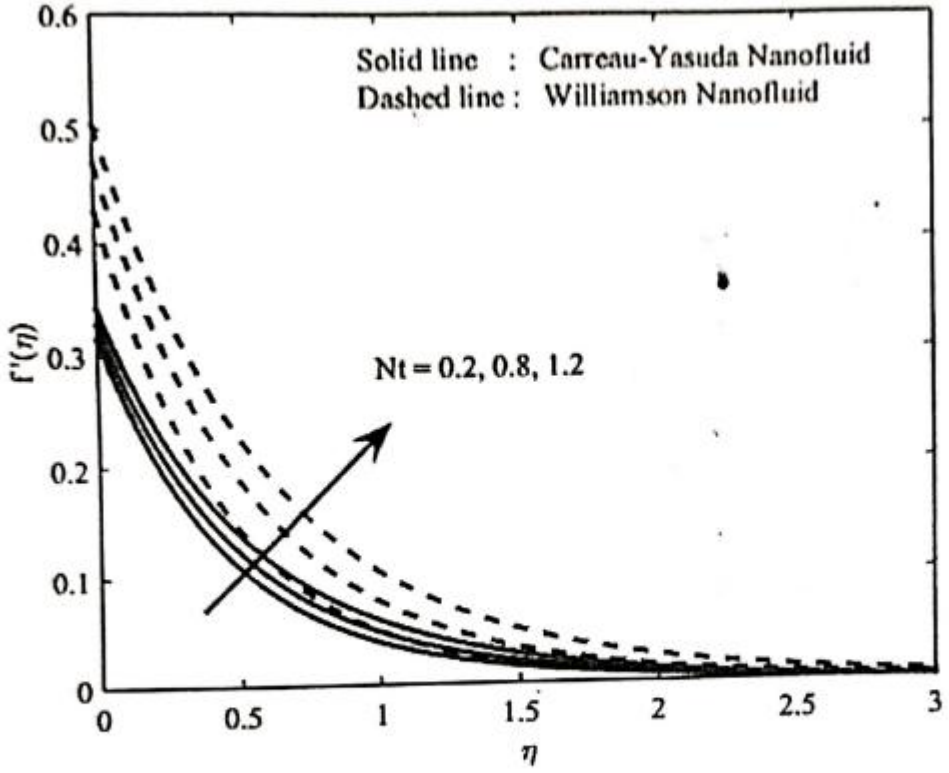

Fig. 5 Influence of *Nt* on velocity profile.

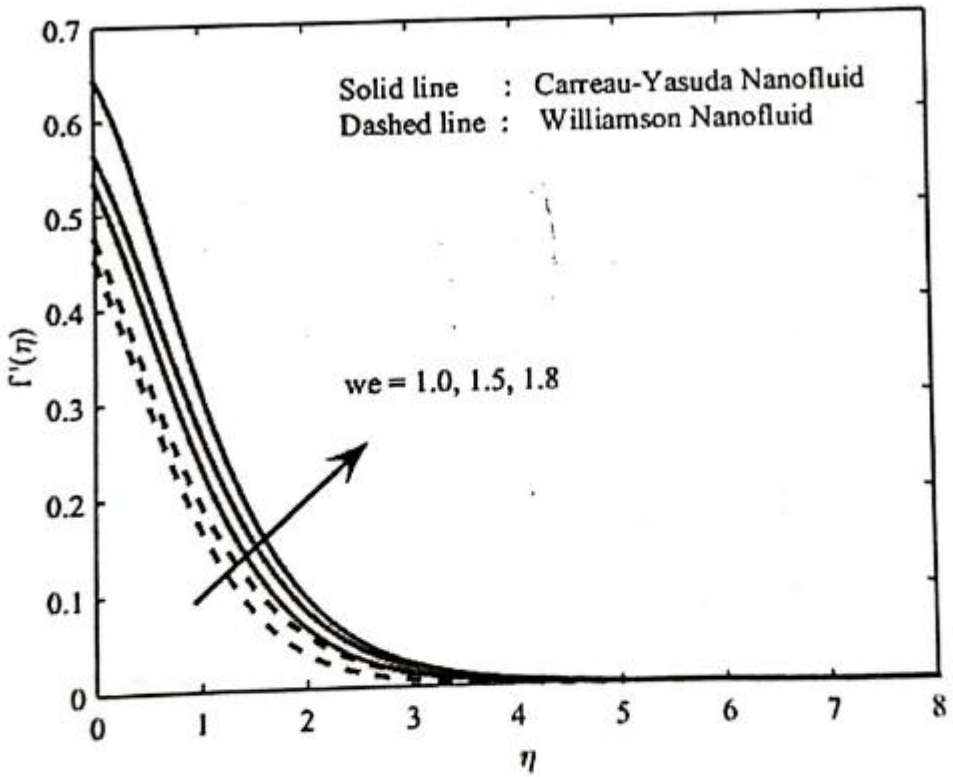

Fig. 6 Influence of *we* on velocity profile.

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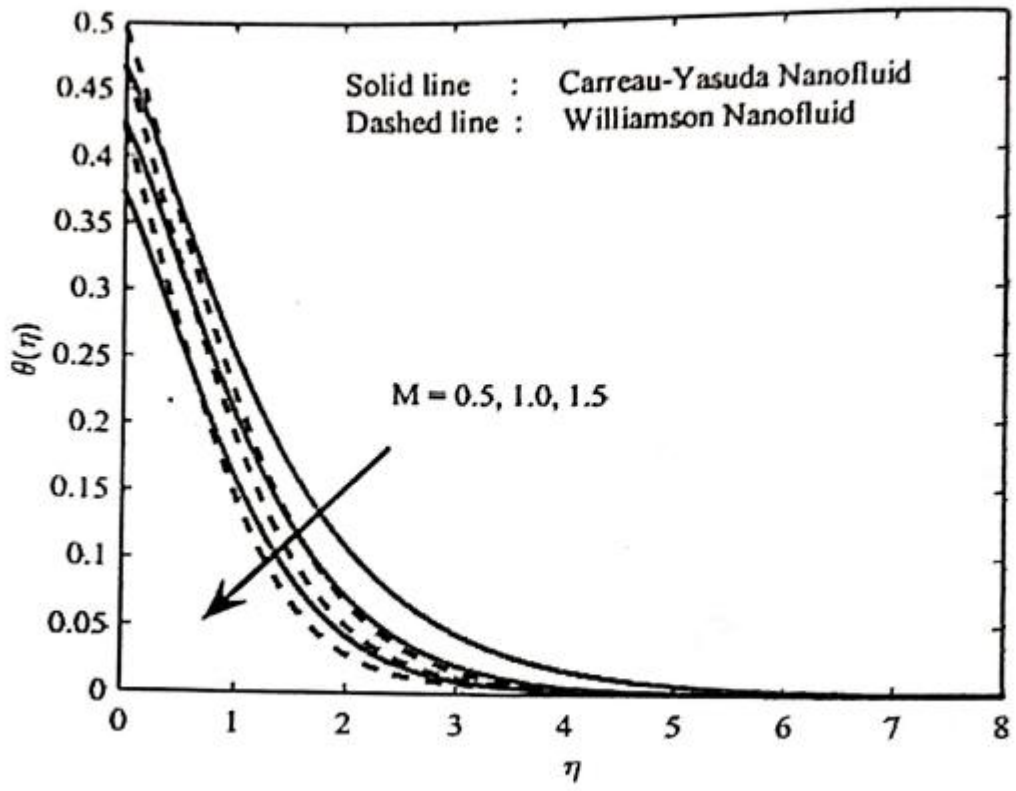

Fig. 7 Influence of M on temperature profile.

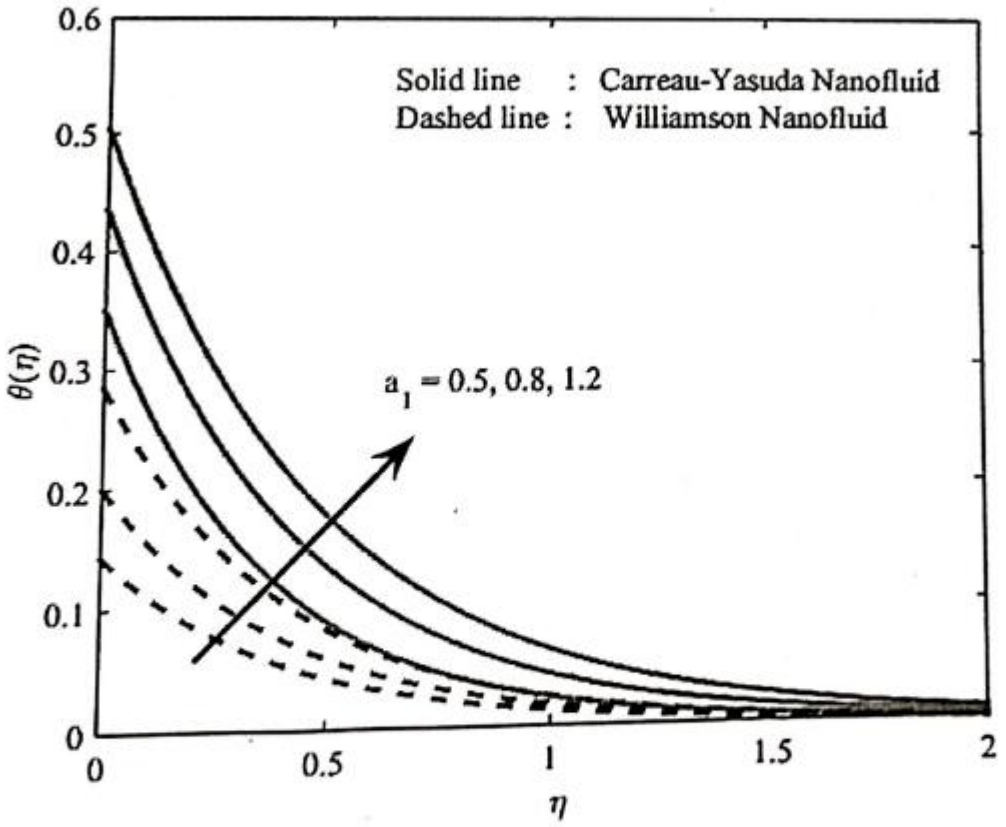

Fig. 8 Influence of a_1 on temperature profile.

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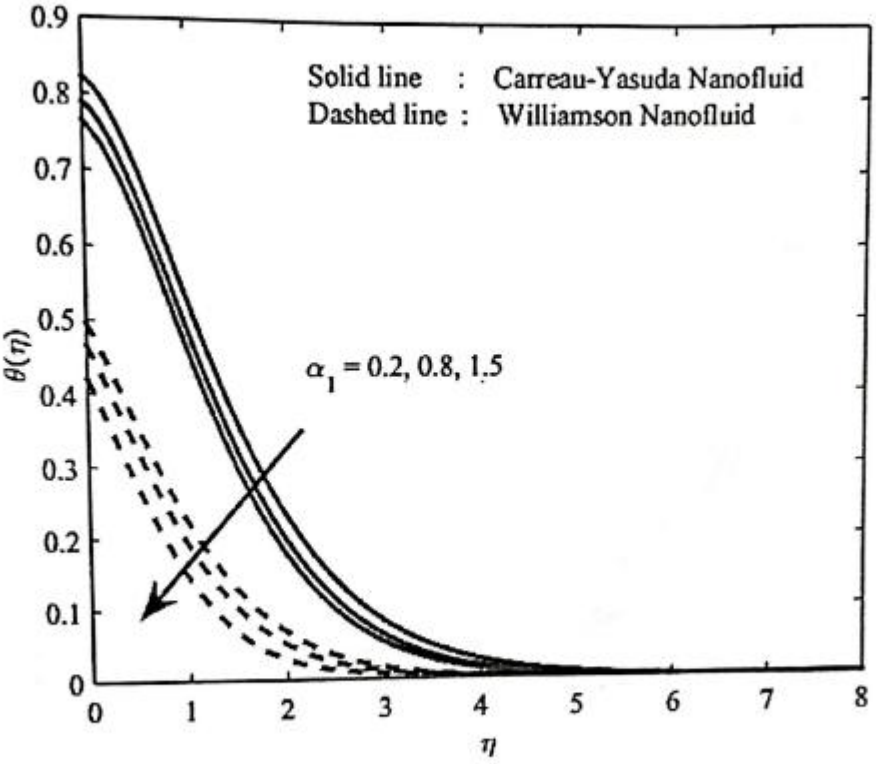

Fig. 9 Influence of α_1 on temperature profile.

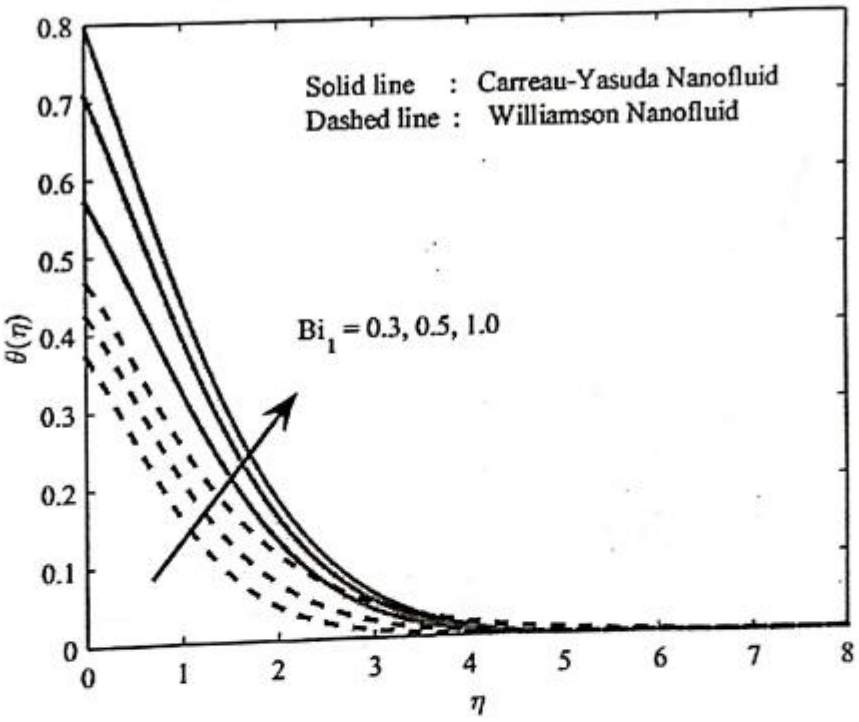

Fig.10 Influence of Bi_1 on temperature profile.

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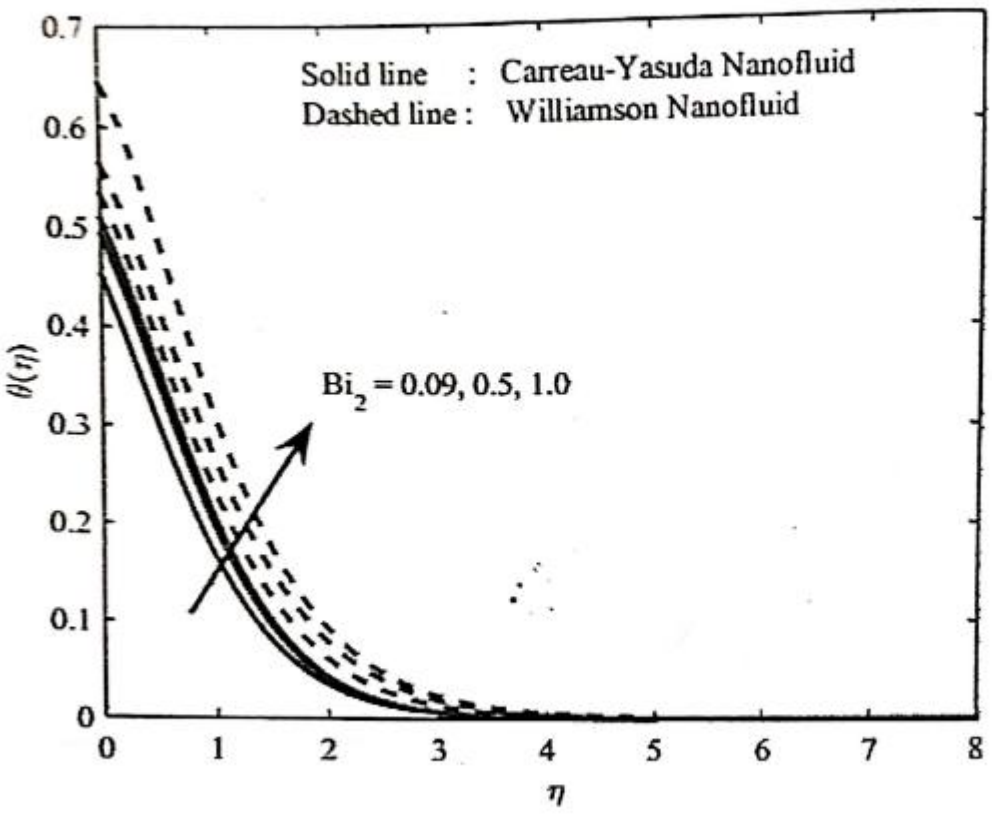

Fig.11 Influence of Bi_2 on temperature profile.

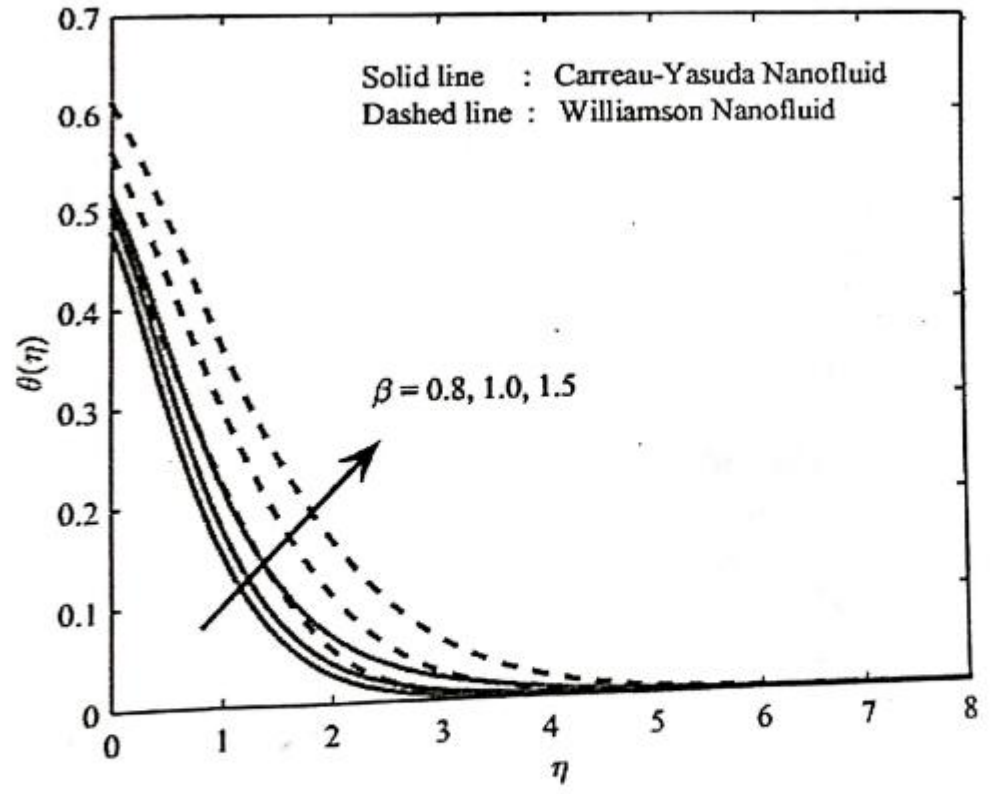

Fig. 12 Influence of β on temperature profile.

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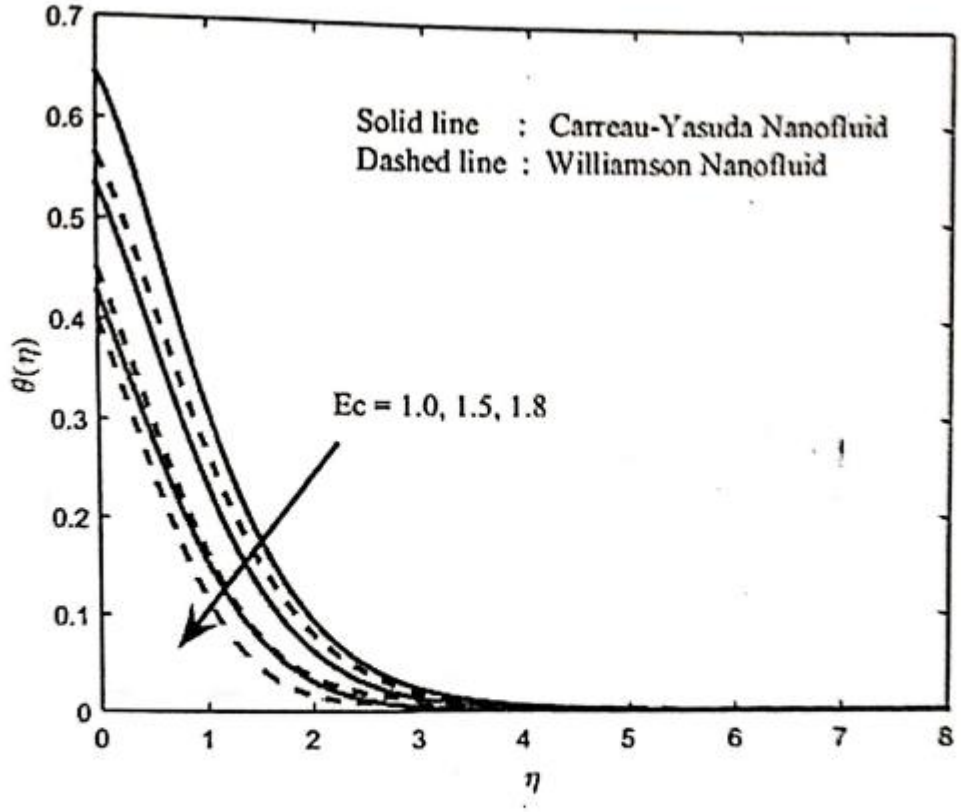

Fig. 13 Influence of Ec on temperature profile.

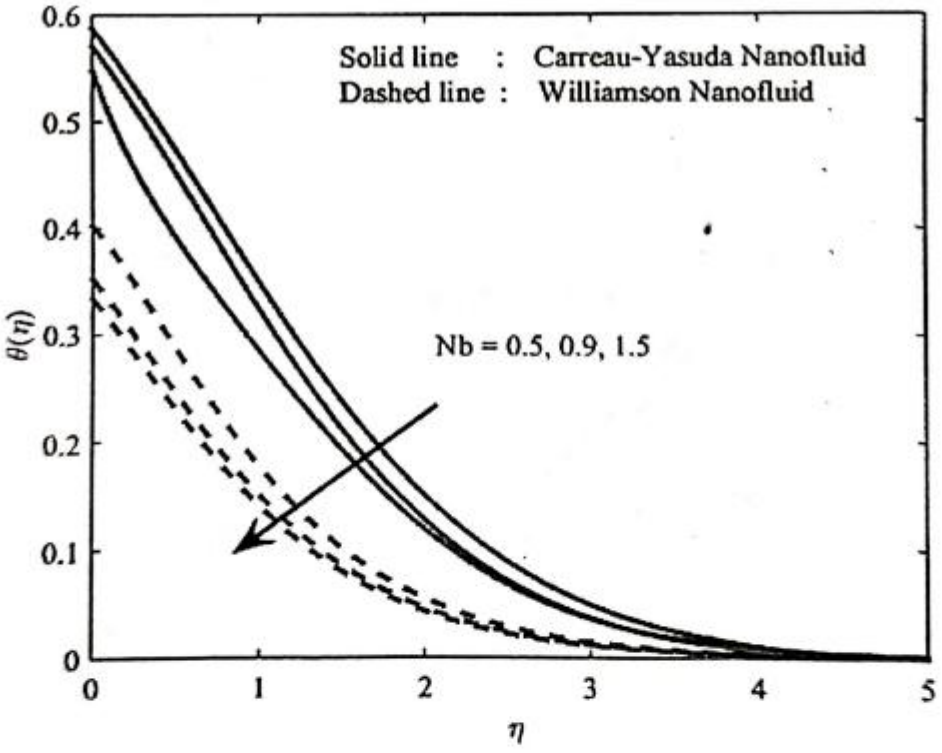

Fig. 14 Influence of Nb on temperature profile.

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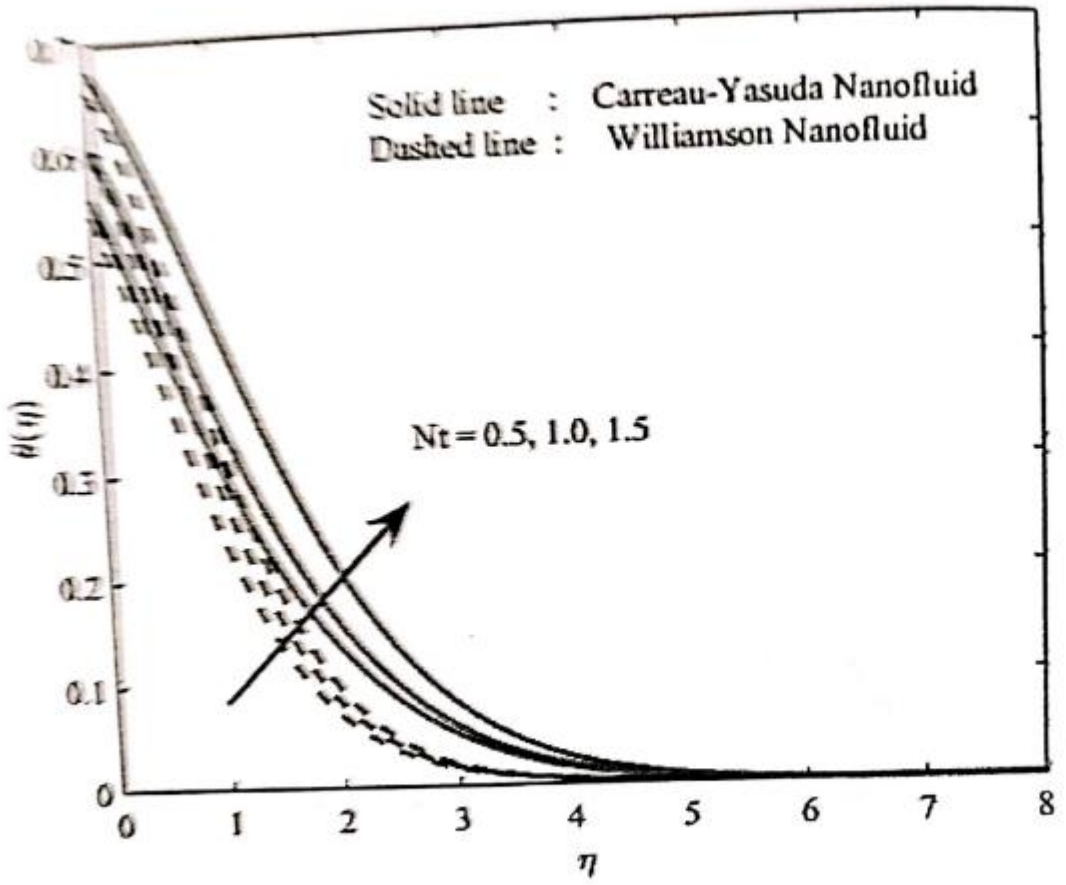

Fig. 15 Influence of Nt on temperature profile.

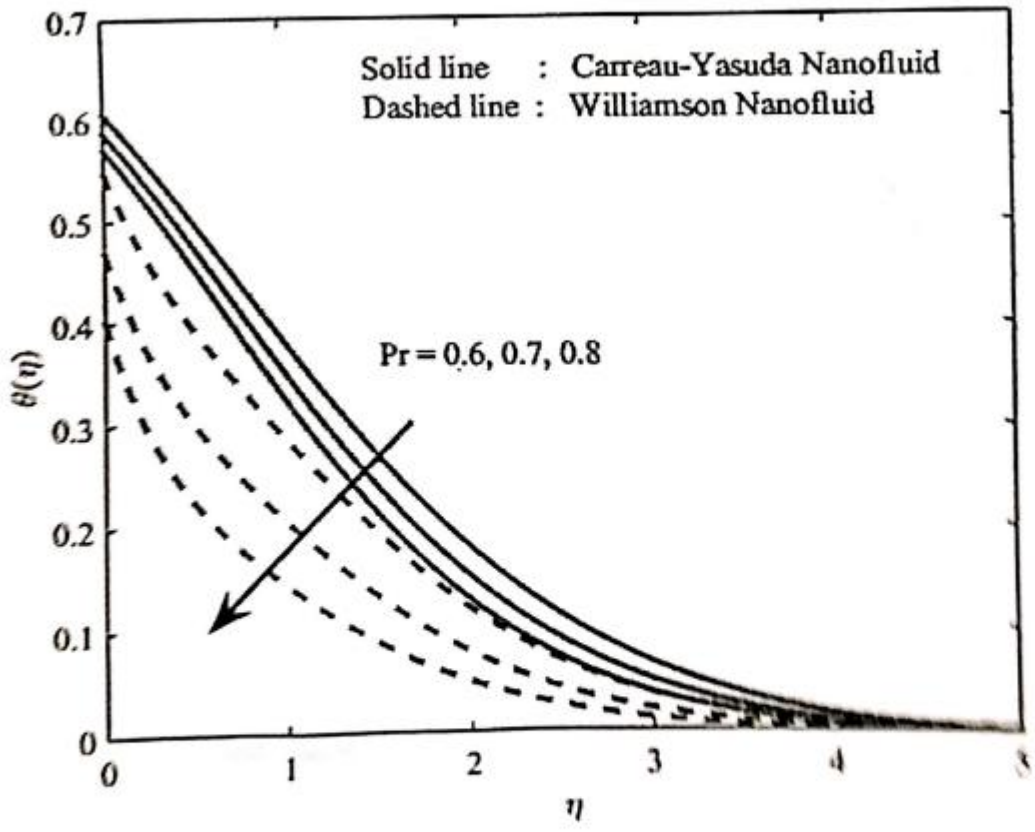

Fig. 16 Influence of Pr on temperature profile.

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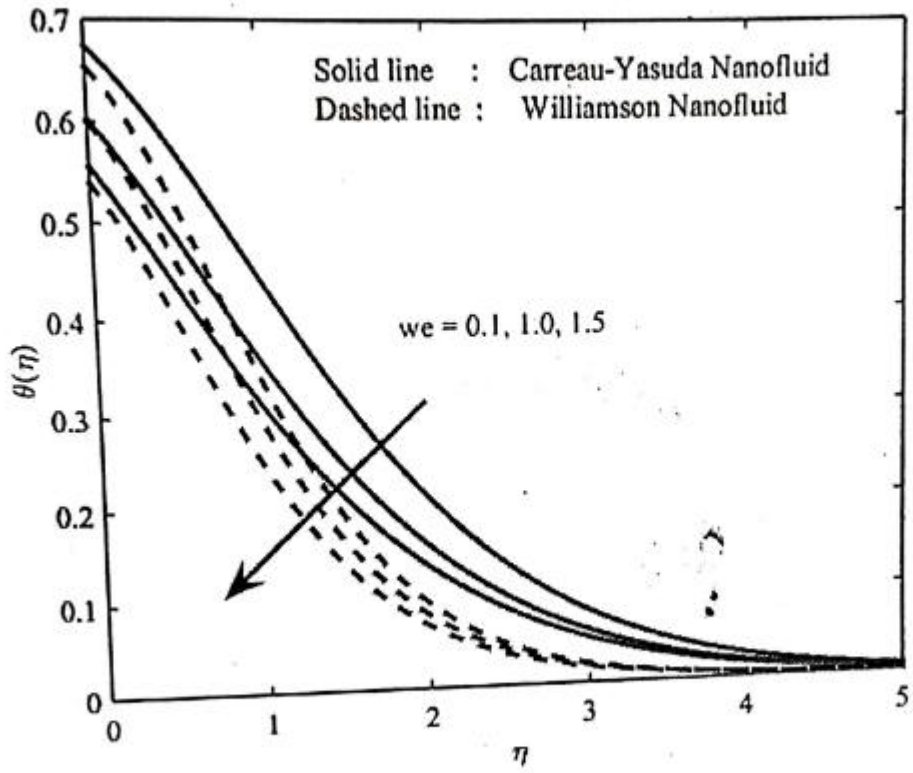

Fig.17 Influence of We on temperature profile.

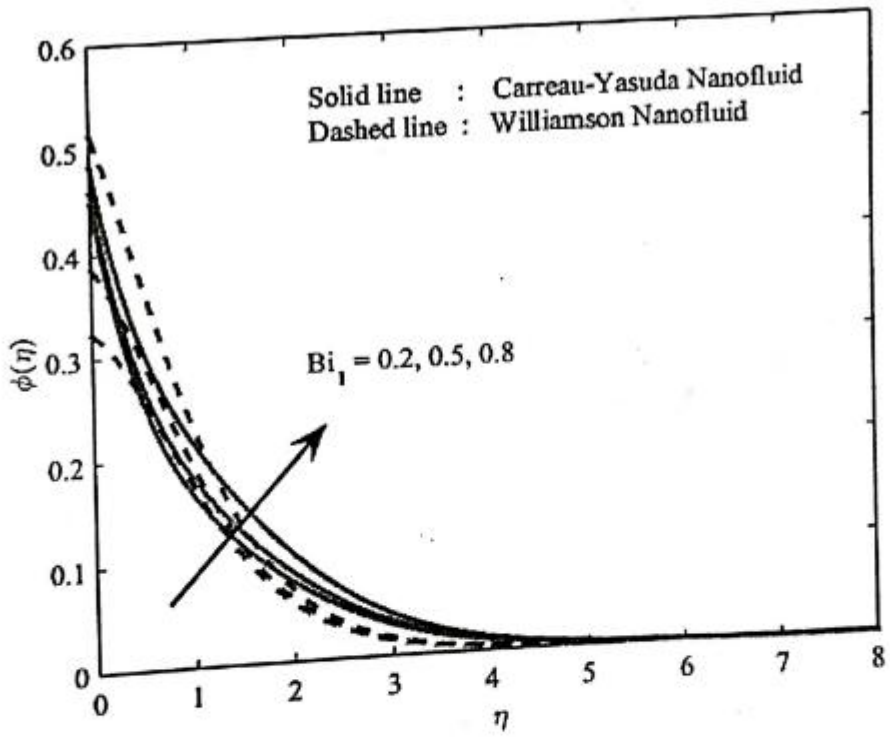

Fig. 18 Influence of Bi_1 on concentration profile.

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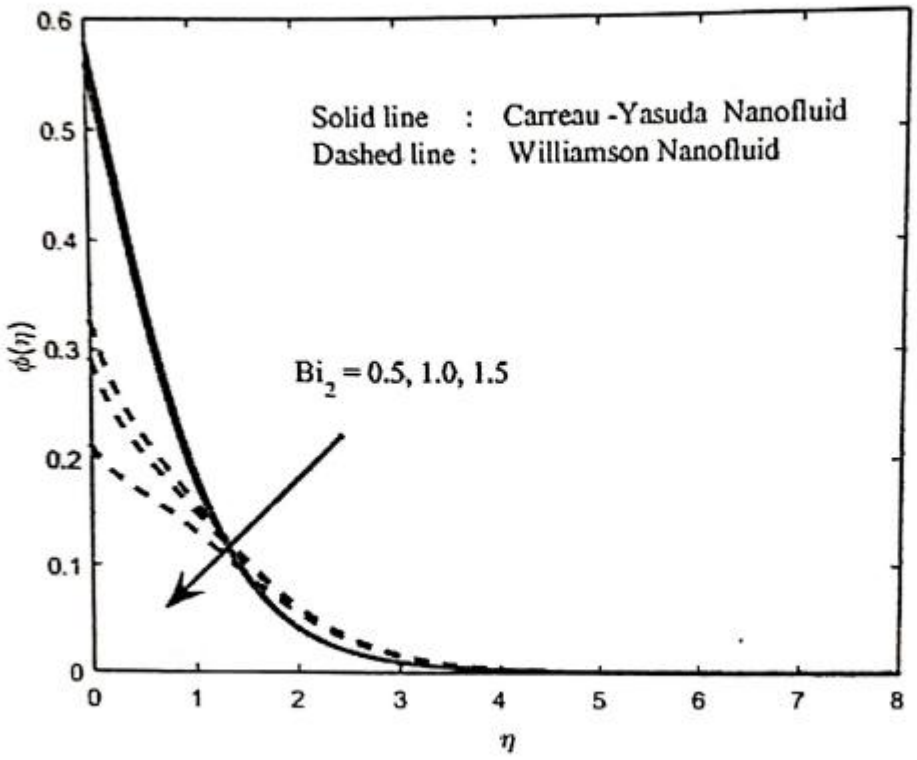

Fig. 19 Influence of Bi_2 on concentration profile.

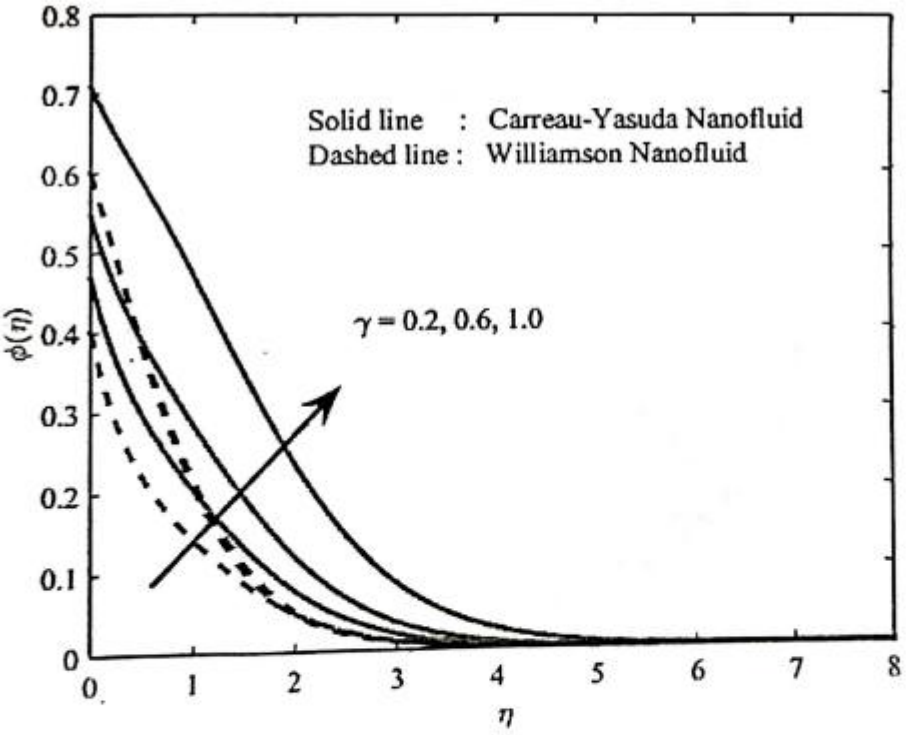

Fig. 20 Influence of γ on concentration profile.

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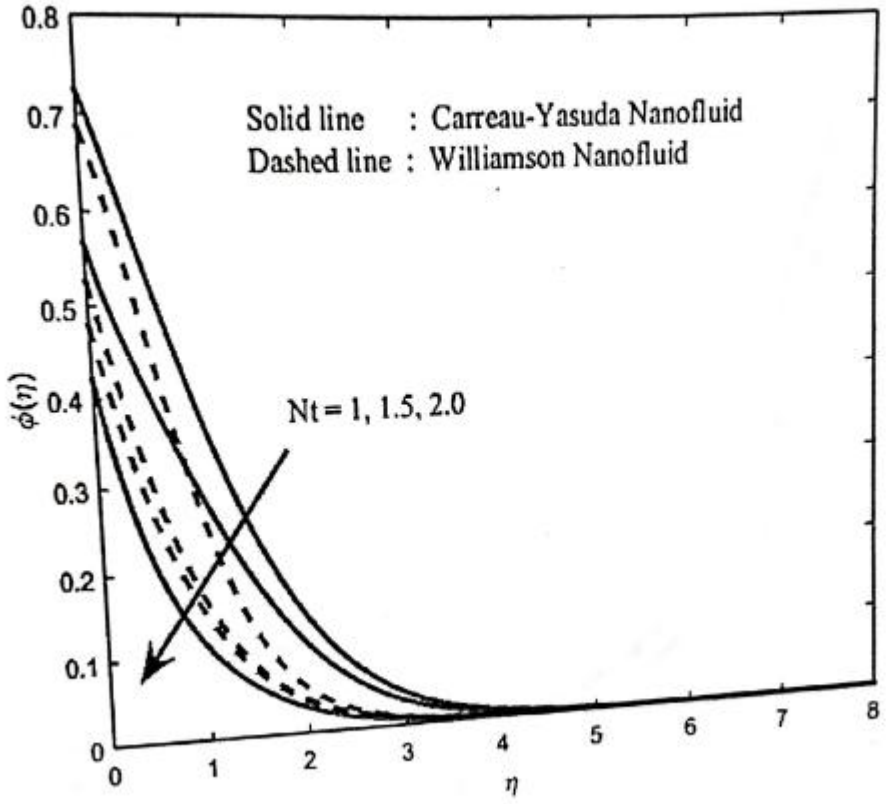

Fig. 21 Influence of *Nt* on concentration profile.

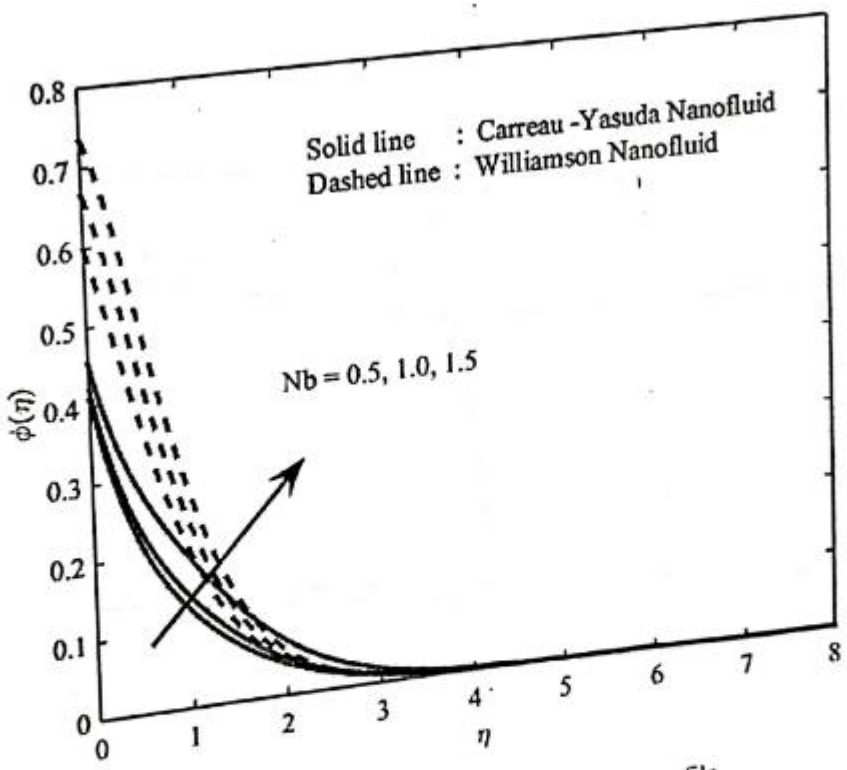

Fig. 22 Influence of *Nb* on concentration profile.

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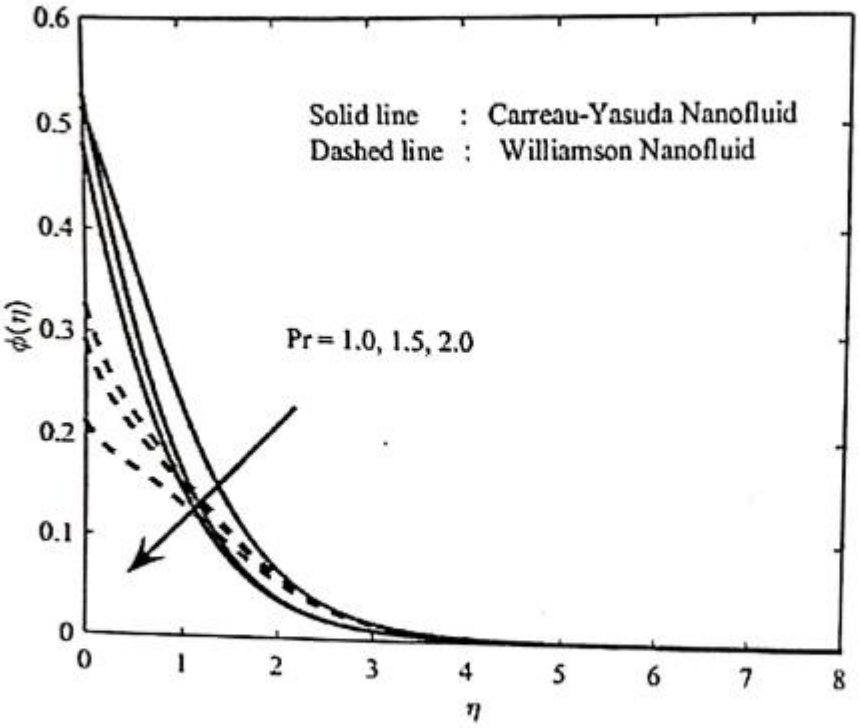

Fig. 23 Influence of Pr on concentration profile.

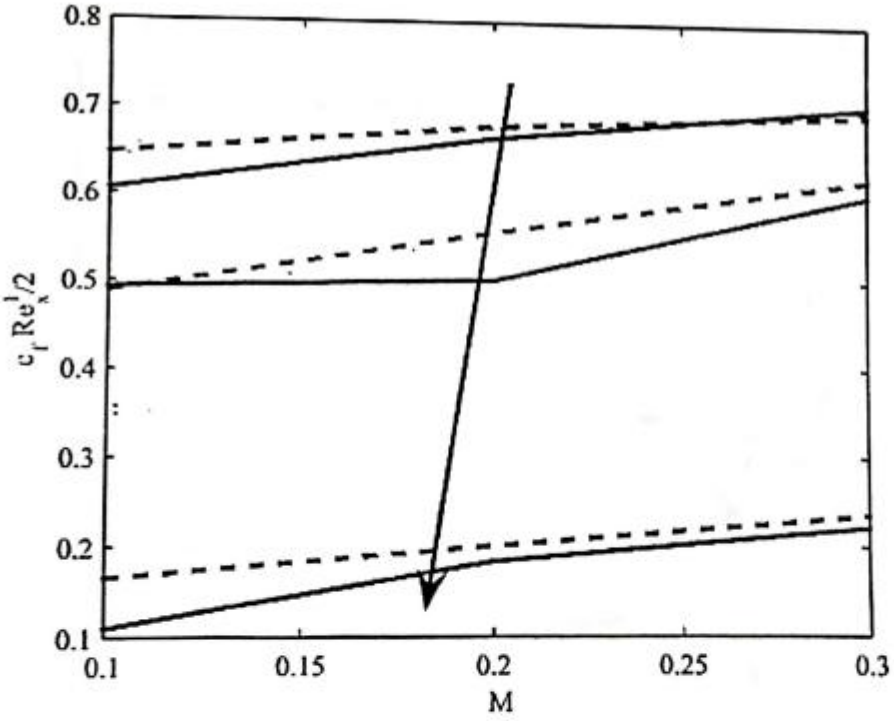

Fig. 24 Influence of M on $c_f \mathrm{Re}_x^{\frac{1}{2}}$.

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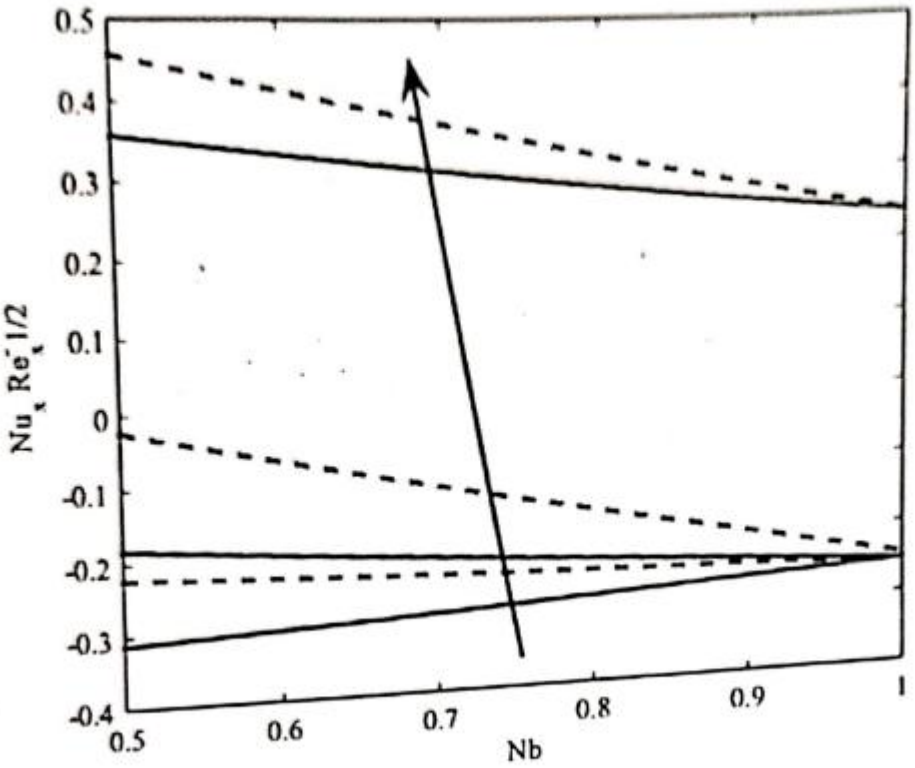

Fig. 25 Influence of Nb on $Nu_x \operatorname{Re}_x^{\frac{-1}{2}}$.

5. CONCLUSSION

In this article the numerical examinations have been finished the limit layer stream, warm exchange of MHD Carreau-Yasuda nano liquids and Williamson fluid over an extending sheet with first order velocity slip, thermal and focus Biot numbers.Conclusion about the effects of various developing parameterson velocity profile $f'(\eta)$, temperature profile $\theta'(\eta)$, concentration profile $\phi'(\eta)$. The key observations of this study are

1. The velocity profile is increasing for Weissenberg number We, thermophoresis parameter Nt and the velocity profile is diminished for magnetic parameter M, Casson parameter β and Eckert number Ec.

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2. The temperature profile is increased for relaxation parameter a_1, thermophoresis parameter Nt, Casson parameter β, thermal Biot number Bi_1, Concentration Biot number Bi_2 and it is decreased for first order velocity parameter α_1, magnetic parameter M, Prandtl number Pr, Weissenberg number We, Brownian motion parameter Nb, Eckert number Ec.
3. The concentration profile improved for Brownian motion parameter Nb, chemical reaction parameter γ, thermal Biot number Bi_1 and it is decreased for Prandtl number Pr, thermophoresis parameter Nt, Concentration Biot number Bi_2.
4. Skin friction coefficient is increased for magnetic parameter, Casson parameter, Eckert number, relaxation parameter, Prandtl number, concentration biot number. While a reverse result is found for first order velocity slip parameter, thermophoresis parameter.
5. Nusselt number is likewise expanded for attractive parameter, Eckert number, Prandtl number, velocity slip parameter, Brownian movement parameter and for Casson parameter, relaxaion parameter, thermophoresis parameter, thermal and focus Biot numbers it is diminished.Sherwood number increased for magnetic parameter, Eckert number, Prandtl number, velocity parameter, thermophoresis parameter, relaxation parameter while it is decreased for Brownian motion parameter, thermal and concentration Biot numbers.

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Land Classification Based on Hyper Spectral Images using Deep Learning Techniques

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Abstract

The study of chemical and physical properties of a remote sensing data is done by one of the form called as Hyper Spectral image. The Hyper Spectral image (HSI) is a captured data with consistent materials in a nonlinear relation form. Each HSI has specific wavelength with spectral reflectance in a matching entries on vector with high dimensional pixels. Although classification of HIS performanceis good based on spectral-spatial but they depend heavily on hand craft or based on shallow descriptors. The ability of representing features in the form of custom made is not sufficient to label the dissimilarity among the classes of altered or same.Extracting the features is measured as essentialtechnique in HSI classification. To extract the features Deep Learning method is used due to classifying the 2D and 3D dimensions and to extract certain shapes in an image etc., can do clearly./And compared what outcomes will come by applying deep learning to the data using Big Data.

Keywords: *Hyperspectral image, Deep Learning, Big data, feature extraction, PCA.*

1. Introduction

In remote sensing Hyper Spectral image [9] is a gather of electromagnetic spectrum with range of observable infrared wavelength which is most important technique. HSIholds the narrow spectral bands in hundreds of bands are collected from the surface of earth and from the area. HSI hasdimensional vector pixel is high and recordsrelate to the spectral reflectance in a definite wavelength. The distinctive spectral dissimilarity is the main advantage which is extensively used in numerous fields.

The major challenge in hyperspectral images are dimensionality because it has highly dimension [1]. The dimensionality of spectral is equivalent to the wholesum of bands, with a piece of band is representing a dimension, and it is large extending in hundreds. When the sum of dimensions is linearly enlarged, the size of feature space rises exponentially. Hence huge volume of data is vital for modelling in the space [5]. Though, the troubles in gathering and outlaysconnected with the analysis of physicaland chemical materials properties, ground truth data is very unusual in hyperspectral datasets. These disastrous combinations of high dimensionality and inadequate ground truth data leads to over fit and consume low generalization performance. This problem has been mentioned as Hughes or dimensionality phenomenon. The classical methodology for this difficultly is called as reduction ofdimensionality [3] which is executed as feature extraction thatalter the spectral to aninferiordimensionillustration or band selection [6] that will choosea subset of most important bands for analysis. To reduce dimensionality hypothesis is used for extracting features in hyper spectral bands over samples which vary gradually in spectrum reflectance at most wavelengths to represent spectral data. Like hypothesis is used for band selection to effect different material properties to manifest in few bands also titled as spectral features, for analysis complete spectrum is not

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Identification of Neighbourhood Cities Based on Landuse Bigdata Using K-Means and K-NN Algorithm

S. VinilaKumari, P. Bhargavi, and S. Jyothi

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Abstract In present days, several cloud computing platforms or web services such as Flip kart and Amazon, Google App Engine, blue cloud etc. provide a locally distributed and scalable data which is in uncountable form. But, these platforms do not regard geographical location data. However, the data is generated from the modern remote satellites with their geological topology. The so obtained geo-distributed database is able to process either a large scale data or a very simple type, scalable while being fault-tolerant and fast in answering a query. The processing of Big data includes the storing and analysing the uncountable amount of geographical data. The big data processing utilizes several programming models and frameworks such as Map Reduce, Hadoop, MongoDB, Pig etc. The present work concentrates on land use classification of various cities in India using geographical location data having latitude and longitude of every boundary. To perform this work, India map shape file with every state is used. The shape file is converted into longitude and latitude band information along with cities data. Nevertheless, the geo-graphical data is classified by applying the machine learning algorithms.

Keywords Big data · Geographical location data · K-NN algorithm · Clustering

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Data Analytics for Land Use and Land Cover Problems: A Survey

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Abstract:

This surveys Land Cover/Land use platforms along with the big data analytics and assesses the advantages and drawbacks of based on every platforms of scalability, data I/O rate, fault tolerance, real time processing, data size data size and iterative task supported. The earth surface is rapidly changing every day due to certain natural reasons and other impacts by society. Over few decades the remote sensing and GIS (Geographic Information System) are the hottest topic for evolving the environments from the earth. The enlargement of several world wide modifications related to the nature of earth, LULC changes are considered as the matter of utmost importance in the natural atmosphere and it has became the interesting area to be studied by researcher on various process like pre-processing, classification and prediction. the flow of LULC change analysis process, the challenges faced during each process by the researchers are discussed. The main objective of this paper is to provide an in depth analysis of different platforms available for performing data analytics in Land Use/ Land Cover.

Keywords: *Land use, land cover, remote sensing, GIS, OSM.*

1. Introduction

Traditionally, humanoids devise remained altering the land to acquire the basics for their existence; however the amount of utilization existed is not similar as current situation. Current quick level of utilization has carried unparalleled variations in environments and ecological procedures at resident, county and worldwide scales. At present, use of land/ cover of land variations involve the ecological fears of humanoid people including change in climate, biodiversity exhaustion and water pollution, loam and air. Nowadays, the observing and refereeing the adversative concerns of land cover/land use alteration while supporting the manufacture of vital properties has convert a key precedence of scholars and strategy creators around the biosphere [1].

Mapping and classifying the covering of land is an essential phase in accepting the systems Earth's biophysical as shown in figure 1. Information of the region and dissemination of nature habitation, for illustration, handling and justifying of growth are influences on sheltered and imperilled sorts. Likewise, info on the region, kind, and outline of roads, buildings, and additional impermeable land cover expedites.

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TOURISM IN INDIA- IMPACT & INITIATIVES

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Abstract

Travel & Tourism creates jobs, drives exports, and generates prosperity across the world. Today tourism is the largest service industry in India, with a contribution of 6.23 per cent to the national Gross Domestic Product and providing 8.78 per cent of the total employment. Foreign Tourist Arrivals (FTA) crossed the 10 million milestone in 2017 and the growth trend is expected to continue over the coming years. The introduction of E-Visa has led to a strong surge in FTAs which extended to citizens from 166 countries for visit to India through 28 international airports. Key initiatives undertaken by Government of India, Ministry of Tourism, which includes launching of 'Incredible India 2.0 campaign' with market specific content and advertising for tourism development in India. The major challenges faced by the Indian tourism industry are deficiencies in infrastructure like sanitation, living facilities, hotels, etc., and inadequate connectivity between cities and tourist locations and security issues etc. According to the World Travel and Tourism Council, India will be a tourism hotspot from 2009-2018, having the highest 10-year growth potential. Moreover, India has been ranked the "best country brand for value-for-money" in the Country Brand Index survey.

Keywords: GDP, FTA, Incredible India 2.0 Campaign, E-Visa.

1. Introduction

Tourism is one of the powerful operators of employment and wealth globally. The activity of tourism in various countries is reflected the most significant than creation concerning to the financial characteristics as well as social impacts. For a growth of economy tourism is an exceptional facilitator that's why it is a vital part in macroeconomic level. This business is imperative to force labour and is essential cause of government's revenues. As one of the world's largest economic sectors, Travel & Tourism creates jobs, drives exports, and generates prosperity across the world. The sector, comprised of a wide range of industries, aims to serve and support domestic, international, business and leisure visitors. Companies, large and small, in industries ranging from accommodation and transportation to food & beverage, retail and culture and sports & recreation, all strive to create products and services that bring people together, support communities and celebrate the wonders that our world can offer.

Each year, WTTC conducts annual analysis quantifying the global economic and employment impact of travel & tourism. In 185 countries and 25 regions, the World Travel & Tourism

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THE EFFECT OF THE THICKNESS OF THE POROUS MATERIAL ON THE PARALLEL PLATE CHANNEL FLOW OF CASSON FLUID WHEN THE WALLS ARE PROVIDED WITH NON-ERODIBLE POROUS LINING

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ABSTRACT

In this analysis the effect of the thickness of the porous material on the parallel plate channel flow of Casson fluid when the walls are provided with non-erodible porous lining is studied. The governing partial momentum equation is transformed to ordinary differential equation by using non-dimensional quantities and solved it analytically. The impacts of governing parameters on the fluid velocity are shown in graphically. We investigated the flow in the free flow region and porous flow regions by using Darcy law and Casson model respectively.

Key words: Casson parameter; porous lining; parallel plate channel.

Introduction

In recent years considerable interest has been evinced in the study of flow past porous media because of its application in industrial, bio-physical and hydrological problems. In the study of flow past a porous material it is customary to use the no-slip boundary condition at the porous surface where the effect of porosity is taken care of by the continuity of the normal component of velocity. Beavers and Joseph [1] studied for the first time, this class of flows past a naturally permeable bed with slip at the nominal surface. Krishna Murthy *et al.* [2-7] developed thermophoresis and brownian motion effects on three dimensional MHD slip flow of a Casson nanofluid over an exponentially stretching sheet. MHD boundary layers slip Casson fluid flow over a dissipated stretched cylinder. Slip effects on MHD three dimensional flow of Casson fluid over an exponentially stretching surface. MHD three dimensional flow of Casson fluid over an unsteady exponentially stretching sheet with slip conditions. Hydromagnetic flow of Casson fluid through a vertical deformable porous stratum with viscous dissipation and chemical

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reaction and effects of heat and mass transfer flow of a Jeffrey fluid through a vertical deformable porous stratum. Sreenadh *et al.* [8] investigated MHD Couette flow of a Jeffrey fluid over a deformable porous layer. Effect of heat transfer on free surface flow of a Jeffrey fluid over a deformable permeable bed was discussed by Eswara Rao *et al.* [9]. Krishna Murthy [10] presented MHD Couette flow of Jeffrey fluid in a porous channel with heat source and chemical reaction.

The present study deals with the effect of the thickness of the porous material on the parallel plate channel flow of Casson fluid when the walls are provided with non-erodible porous lining is studied. We investigated the flow in the free flow region and porous flow regions by using Darcy law and Casson model respectively. The governing velocity equation is solved by closed form solution. We found the flow in the free flow region and porous flow regions by using Darcy law and Casson model respectively.

MATHEMATICAL MODEL OF THE PROBLEM

Consider, the steady flow of a Casson fluid through a channel formed a channel by two rigid impermeable parallel plates at $y=0$ and $y=h$ is represented in Figure 1. The lower wall is covered with a homogeneous and isotropic permeable material of thickness $h'(\neq 0)$. Thus dividing the flow region into two zones, Zone 1 represents the region of the free flow between the upper impermeable wall and the nominal surface $y=h'$ and Zone 2 denoting the region of flow through the porous material.

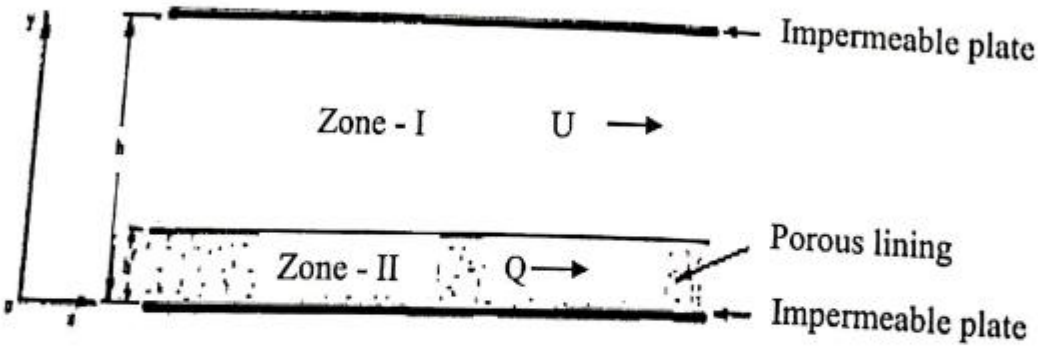

Figure 1. Physical geometry of the problem

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The flow which is caused by a uniform pressure gradient in the longitudinal direction in both the zones is assumed to be fully developed and the fluid properties are all assumed to be constant. Then the flow in Zone I is governed by the Navier-Stokes equation is

$$\mu\left(1+\frac{1}{\beta}\right)\frac{\partial^2 u}{\partial y^2}=\frac{\partial p}{\partial x} \tag{1}$$

and that in Zone II by the Darcy law

$$\mu\left(1+\frac{1}{\beta}\right)Q=-K\frac{\partial p}{\partial x} \tag{2}$$

The boundary conditions are as follows:

$$\left.\begin{aligned} &u=0\,at\,y=h\\ &\frac{\partial u}{\partial y}=\frac{\alpha}{\sqrt{K}}\left(u_s-Q\right)at\,y=h'\end{aligned}\right\} \tag{3}$$

The non-dimensional quantities are as follows:

$$\upsilon=\frac{u}{\bar{u}},\eta=\frac{y}{h},\xi=\frac{x}{h},\pi=\frac{p}{\frac{1}{2}\rho\bar{u}^2},R=\frac{\rho\bar{u}h}{\mu},P=-\frac{R}{2}\frac{\partial\pi}{\partial\xi},\sigma=\frac{h}{\sqrt{K}},Q'=\frac{Q}{\bar{u}},\varepsilon=\frac{h'}{h} \tag{4}$$

Where u is the velocity, β is the Casson parameter, p is the pressure, μ is the dynamic viscosity, Q is the Darcy velocity, K is the absolute permeability of the material, u_s is the slip velocity at the nominal surface, α is the slip parameter, h is the height of the channel and h' is the thickness of the porous lining, ρ is the fluid density, R is the Reynolds number, $\bar{u}$ is the average velocity in the channel, ε is the thickness of the porous channel.

From equations (1) – (4) we get the following equations are

$$\frac{d^2\upsilon}{d\eta^2}=-\frac{P}{\left(1+\frac{1}{\beta}\right)} \tag{5}$$

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$$Q' = \frac{P}{\sigma^3\left(1+\frac{1}{\beta}\right)} \tag{6}$$

The following non dimensional boundary conditions are

$$\left.\begin{aligned} &\upsilon = 0 \, at \, \eta = 1 \\ &\frac{d\upsilon}{d\eta} = \alpha\sigma(\upsilon_s - Q') \, at \, \eta = \varepsilon \end{aligned}\right\} \tag{7}$$

Where υ_s is the slip velocity

Solution of the problem

In this paper we solved the governing equation with the closed form solution. The solution of (5) satisfying (7) is

$$\upsilon(\eta) = (1-\eta)\left[\frac{P(1+\eta)}{2\left(1+\frac{1}{\beta}\right)} - \frac{P\varepsilon}{\left(1+\frac{1}{\beta}\right)} - \alpha\sigma\upsilon_s + \frac{\alpha P}{\sigma\left(1+\frac{1}{\beta}\right)}\right] \tag{8}$$

$$\text{Where } \upsilon_s = \frac{P(1-\varepsilon)\left[\sigma(1-\varepsilon)+2\alpha\right]}{2\sigma\left(1+\frac{1}{\beta}\right)\left[\sigma\alpha(1-\varepsilon)+1\right]}, \quad 0<\varepsilon<1 \tag{9}$$

We are interest to find the quantitative effect of slip on the flow, we calculate the non-dimensional mass flow rate

$$M = M_1 + M_2 \tag{10}$$

$$\text{Where } M_1 = \int_{\varepsilon}^{1} \upsilon d\eta = \frac{P}{12}\frac{(1-\varepsilon)^3}{\left(1+\frac{1}{\beta}\right)}\left[\frac{4+\alpha\sigma(1-\varepsilon)-6\alpha^2}{1+\alpha\sigma(1-\varepsilon)}\right] + \frac{\alpha P}{2\sigma}\frac{(1-\varepsilon)^3}{\left(1+\frac{1}{\beta}\right)} = \frac{P}{12}A + \frac{P}{2}B \tag{11}$$

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and $$M_2 = Q'\varepsilon = \frac{P\varepsilon}{\sigma^2\left(1+\frac{1}{\beta}\right)} \tag{12}$$

In order to bring out the effect of porous lining in the channel we compare M with the mass flow rate M^* in the channel in the absence of lining where

$$M^* = \int_0^1 \upsilon d\eta = \frac{P}{3\left(1+\frac{1}{\beta}\right)} \tag{13}$$

Then the ration of the mass flow rate with and without porous lining is given by

$$\frac{M}{M^*} = \frac{A}{4} + \frac{3B}{2} + \frac{3\varepsilon}{\sigma^2} \tag{14}$$

Results and Discussion

In this paper we examine the impact of the thickness of the porous material on the parallel plate channel flow of Casson fluid when the walls are provided with non-erodible porous lining is studied. We investigated the flow in the free flow region and porous flow regions by using Darcy law and Casson model respectively. The governing equation is solved with closed form solution. The influences of governing parameters on the fluid velocity from equation (8) are displayed with the help of graphs for the flow in a channel with one side porous lining.

The effect of thickness of porous layer ε on the fluid velocity $\upsilon(\eta)$ is shown in Figure 2. We noticed that the velocity reduces for higher values of thickness of porous layer. The impacts of slip parameter α and the permeability parameter σ on the fluid velocity $\upsilon(\eta)$ are displayed in Figures 3and 4. We observed that the fluid velocity decay with increasing slip parameter and permeability parameter. The impact of pressure gradient P on the fluid velocity $\upsilon(\eta)$ is depicting in Figure 5. We have seen that the fluid velocity enhances for higher values of pressure gradient. From figure 6 represent the influence of Casson parameter β on the fluid velocity $\upsilon(\eta)$

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We reveal that the fluid velocity decreases with increasing Casson parameter. This causes yield stress. The ratio of mass flow rate M/M^{*} covering one side porous lining suppresses for higher values of the permeability parameter σ. Further for higher values of slip parameter α decays the ration of mass flow rate is represented in Figures 7 and 8.

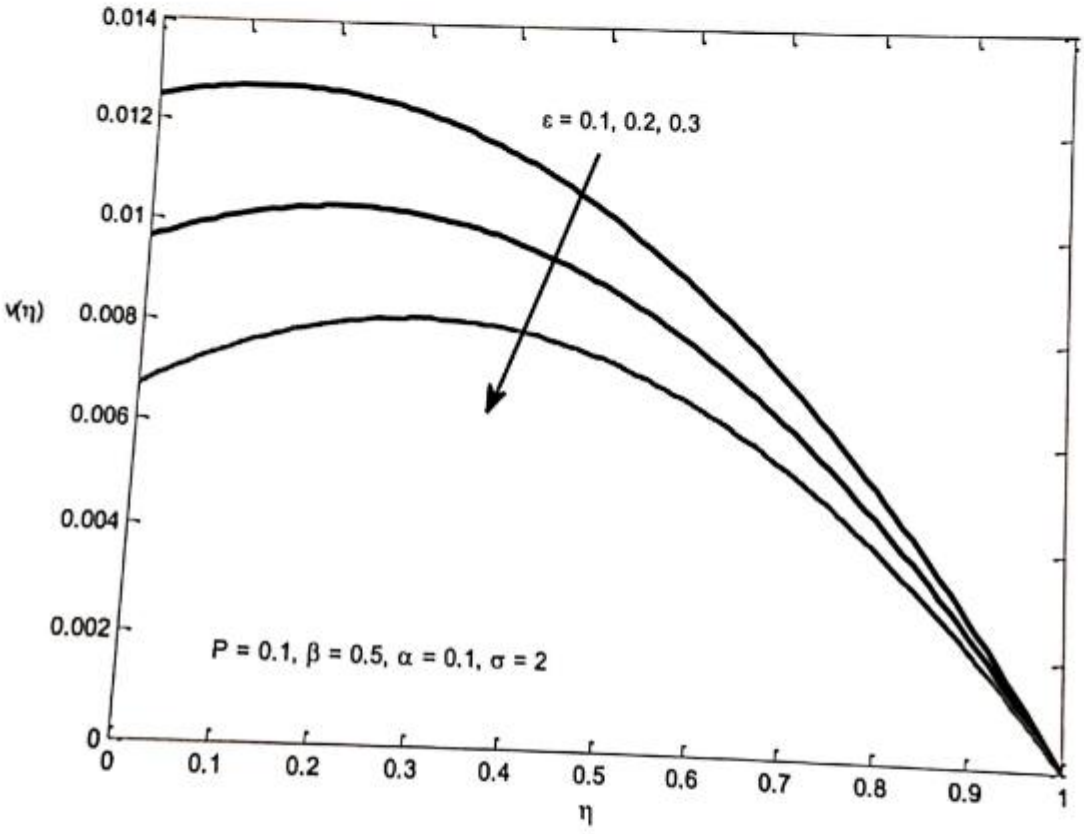

Figure 2. The impact of ε on the fluid velocity $\upsilon(\eta)$

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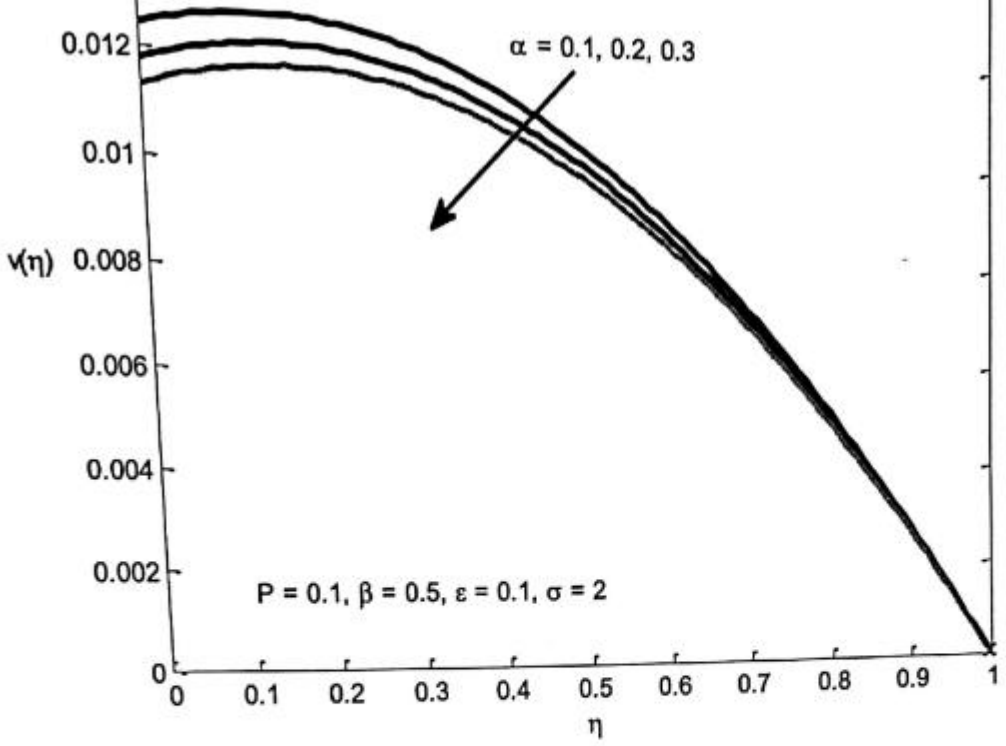

Figure 3. The impact of α on the fluid velocity $\upsilon(\eta)$

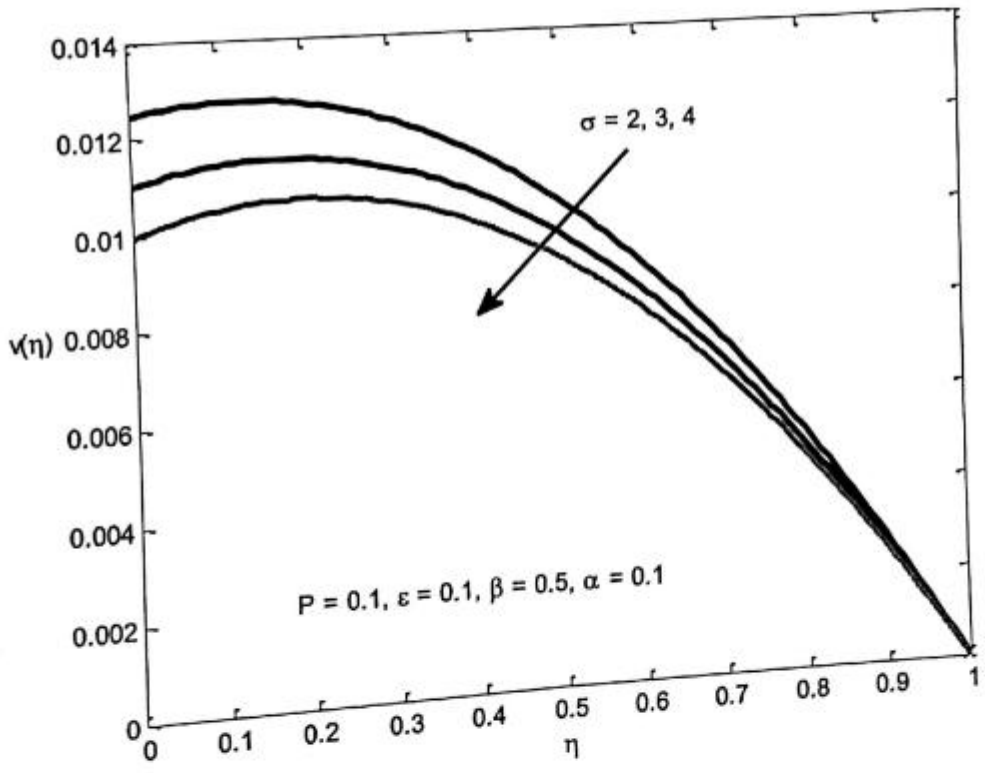

Figure 4. The impact of σ on the fluid velocity $\upsilon(\eta)$

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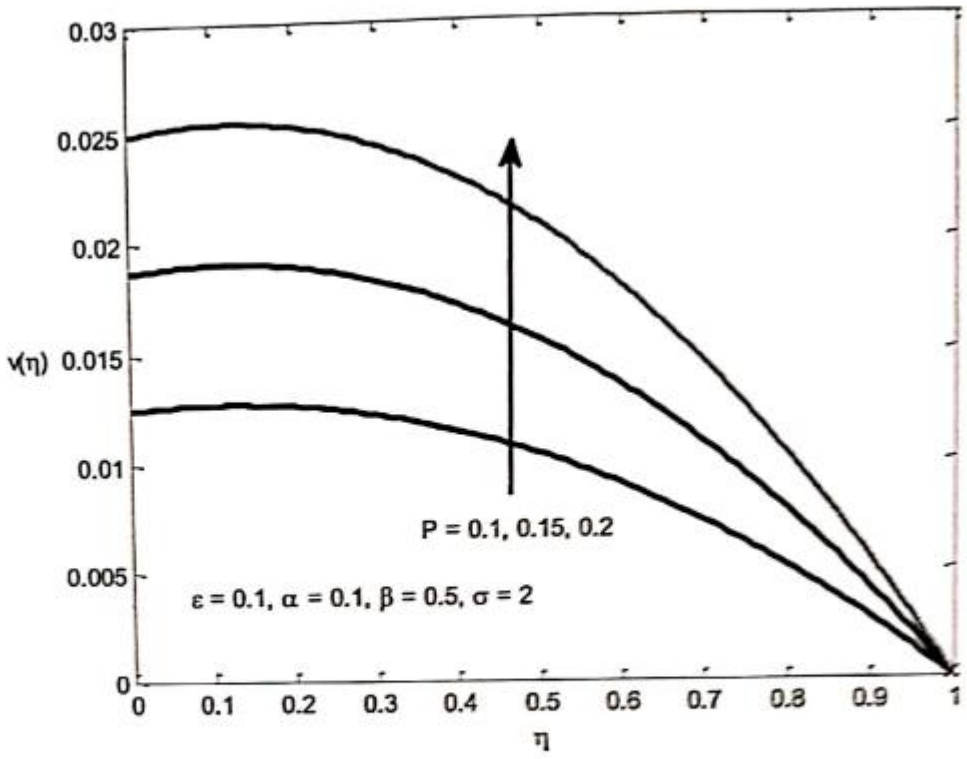

Figure 5. The impact of P on the fluid velocity $v(\eta)$

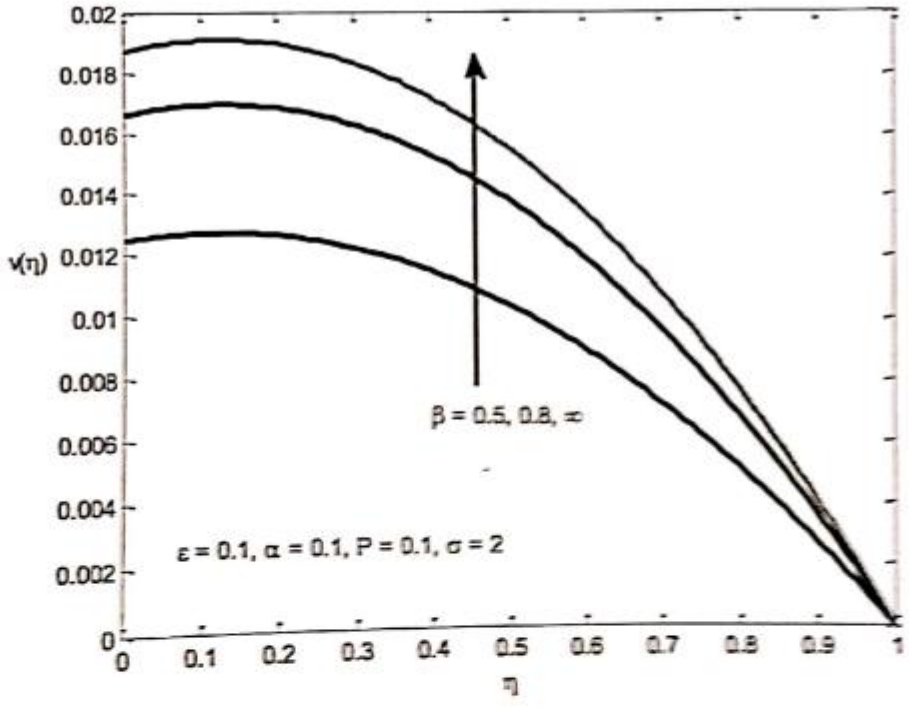

Figure 6. The impact of β on the fluid velocity $v(\eta)$

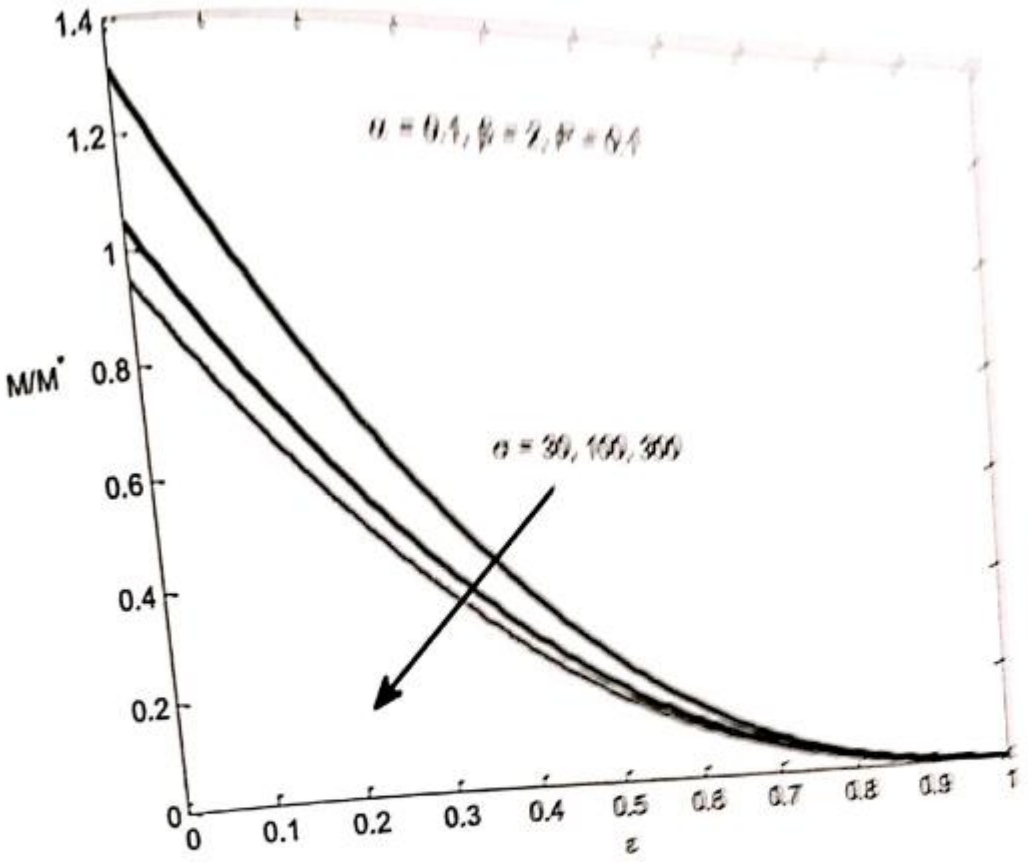

Figure 7. The impact of σ on the mass flow rate M/M^* for $\alpha=0.1$

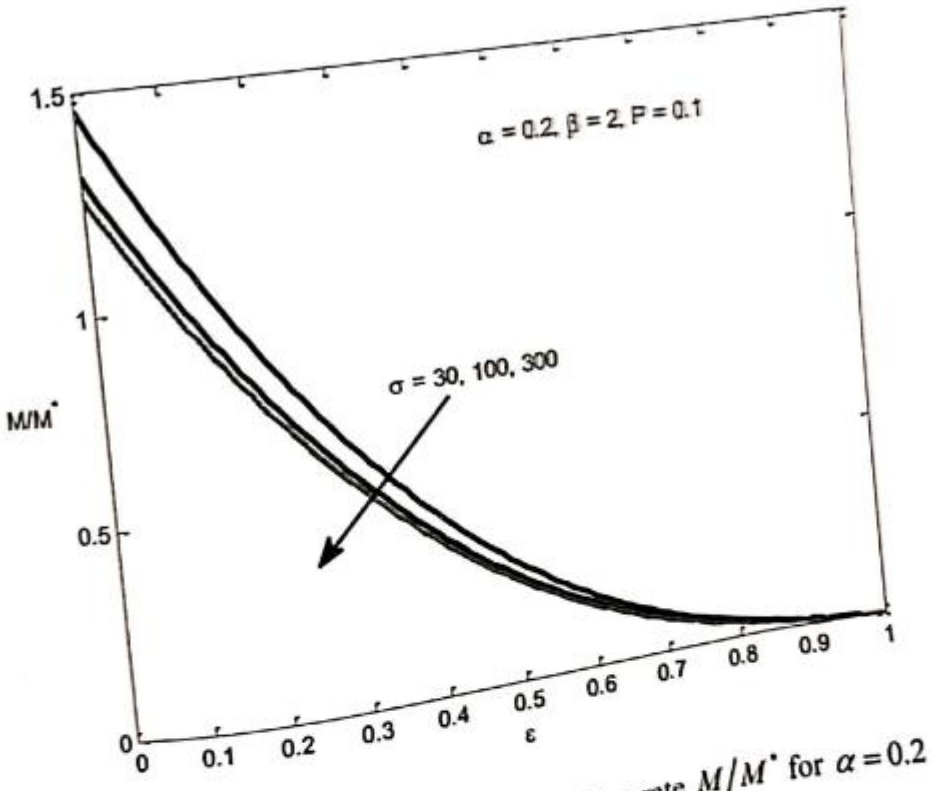

Figure 8. The impact of σ on the mass flow rate M/M^* for $\alpha=0.2$

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On the applicability of HAM to seek periodic solution for truly nonlinear oscillator

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ABSTRACT

Homotopy perturbation method (HPM) is claimed to be a simple analytic approximation method suitable for solving nonlinear differential equations. It assures solution series convergence by transferring the nonlinear problem into a number of linear sub-problems. A differential equation which is really nonlinear oscillator is considered for obtaining periodic solution using the HPM. To examine the adequacy of HPM, the phase diagram made from the approximate solution is studied with respect to the actual phase diagram.

Key words: Amplitude; Equation of motion; Frequency parameter; Homotopy perturbation method; Phase diagram.

1. INTRODUCTION

Perturbation and asymptotic approximations are generally applicable for weakly nonlinear ODEs (ordinary differential equations) and PDEs (partial differential equations) having small/large physical parameters. Khatami et al. [1] have successfully applied the DTM (differential transform method) and obtained solutions for nonlinear Duffing oscillators. The modified DTM provides inconsistency in the periodic solutions of the nonlinear Duffing oscillators having asymmetric oscillations [2-4]. Many nonlinear differential equations are solved applying the Homotopy Perturbation method (HPM) and the traditional Adomian decomposition method [5-27]. HPM is claimed to be a simple analytic approximation method suitable for nonlinear problems. It transfers into a number of linear sub-problems and assures the solution series convergence. The objective of this research article is to study the competence of the HPM for a truly nonlinear oscillator possessing actual solution.

2. MOTION EQUATION

A DE of order two with nonlinearity of motion for undamped free vibrations is of the form

$$\frac{d^2y}{dt^2} + f(y) = 0 \tag{1}$$

The cubic polynomial restoring force function, $f(y)$ is

$$f(y) = \alpha y + \beta y^2 + \gamma y^3 \tag{2}$$

The Duffing equation is a well-known eg. of system which is nonlinear [28-33]. The non-linear vibration characteristics are studied on laminated beams and plates [34-38].
The truly nonlinear oscillator having the power-law type restoring force function considered here is [39-41]

$$\frac{d^2y}{dt^2} + y^3 = 0 \tag{3}$$

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$$y=1,\ \frac{dy}{dt}=0 \text{ at } t=0 \qquad (4)$$

For the restoring force function, $f(y)=y^3$ in equation (3), the frequency is expected to increase with increasing amplitude [42]. This hardening nonlinearity is depicted by rubber pads in the mounting of machinery under compression. Displacement's cube in the restoring force function can also be depicted by the motion of a ball-bearing oscillating in a U-shaped vertically standing glass tube. Whineray [43] has demonstrated experimentally by constructing a cubic-law air track oscillator. Actual solution is carried out for equation (3) and the improved MDTM is incapable to provide accurate results [4]. A trail has beencarried out here to verify the competence of homotopy perturbation method (HPM) by solving equations (3) and (4). Applying the HPM [44, 45] to equations (3) and (4), the first-order approximation obtained is

$$y(t)=\cos(0.866t)+0.0322\cos(2.598t) \qquad (5)$$

By using the constraints in (4) and taking anti derivatives of (3) it is evident that $(y')^2=\frac{1}{2}(1-y^2)(1+y^2)$ (6)

Figure 1. describes the comparative study of phase diagrams generated from equations (5) and (6).

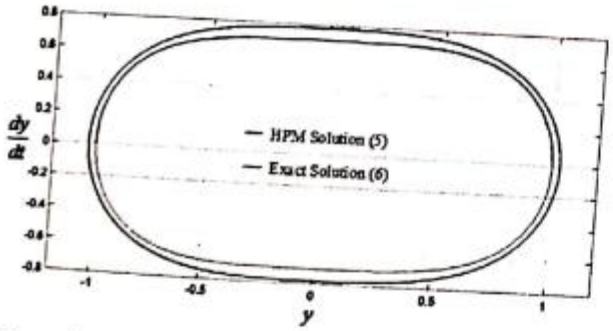

Figure 1. Phase diagrams generation from equations (5) and (6)

The actual solution for (3) and (4) is obtained in Jacobi elliptic cosine function terms of (cn) as [4]

$$y(t)=cn\left(t,\frac{1}{\sqrt{2}}\right) \qquad (7)$$

The angular frequency, $\omega=0.8472$, and it is 0.866 by the 1st approximation of HPM (see equation (5)). Though, slight difference is noticed in the values of angular frequency and amplitude, the trend in the phase diagram from the HPM solution is seen like the actual phase diagram.

$y(t)$ in equation (3) satisfies the initial conditions (4) is assumed in the form

$$y(t)=A_1\cos(\omega t)+(1-A_1)\cos(3\omega t) \qquad (8)$$

By applying the HARMONIC BALANCE METHOD applications and basic trigonometry principles in order to retain only constant terms and terms of $\cos(\omega t)$ and $\cos(3\omega t)$ two equations are obtained. These equations give $A_1=0.9571$ and $\omega=0.8488$. The solution of equations (3) and (4) obtained from equation (8) is

$$y(t)=0.9571\cos(0.8488t)+0.0429\cos(2.5464t) \qquad (9)$$

Figure-2 shows the excellent matching of the PHASE DIAGRAMS created from equations (6) and (9). From Figures 1 and 2, the use of the HBM with higher order harmonics provides results close to the exact, whereas little discrepancy is noticed in the results of the problem using HPM.

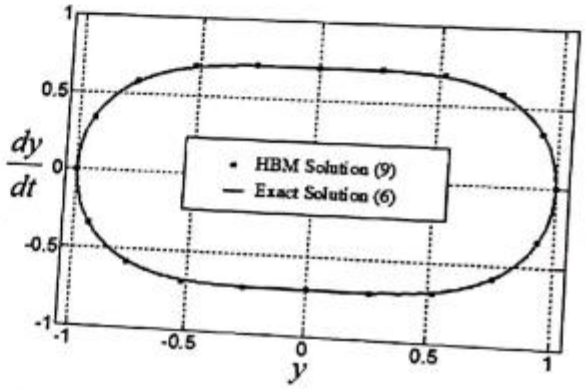

Figure 2. Comparative study of the PHASE DIAGRAMS generated from equations (6) and (9).

3. CONCLUSION

The homotopy perturbation method (HPM) provides approximate solution for the problem of truly nonlinear oscillations comparable with exact solution. In the above conversation we have established that the restoring force function in the truly nonlinear oscillations displacement cube. Usage of the method of harmonic balance with higher order harmonics presents realistic results. This innovative research study demonstrates the drawbacks in the usage of MDTM to get the periodic solution of a simple truly nonlinear oscillator differential equation having exact solution.

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Application of the Homotopy Perturbation method to solve nonlinear oscillatory differential equations

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ABSTRACT

This research article explores on the validation of homotopy perturbation procedure to solve the ordinary differential equations i) nonlinear electrical phenomenon in nonlinear inductor circuit and ii) movement of a ball bearing oscillating in bent tube with smoothness where restoring force is directly proportional to the displacement's cube. This approach gives periodic solution and period of the motion as a function of amplitude of oscillation also. The Homotopy method works very well for the cubic oscillator and good agreement of the approximate frequencies with the exact ones. The significant features of homotopy method are simplicity and its excellent accuracy for the complete range of oscillation amplitude values. This technique is very effective and convenient for solving truly nonlinear oscillatory systems. Here a comparative analysis has been made between two methods namely homotopy perturbation and the formal methods. More interestingly an isomorphism can be seen between the two methods of solution in this paper. Furthermore the uniformity of the validation of solution technique by homotopy perturbation process on entire domain has been depicted and it has been observed that the methods proposed here can be applied to strong systems which are not linear as well as for the weak systems which are considerably weak.

Key words: Homotopy perturbation method (HPM); Modified differential transform method (MDTM), Phase diagram, Truly nonlinear system, Perturbation Method (PM)

1. INTRODUCTION

The study of nonlinear systems has a large number of applications in many branches of applicable mathematics namely physical sciences, management and engineering sciences, The nonlinear. The nonlinear problems are too complex to get the analytic solution but their numerical solution can be obtained by some techniques. On the other side finding the governing differential equations and solving by using the different techniques is also interesting one in mechanics and mathematics. Most of the researchers are working on finding the solutions to these nonlinear equations by using the methods such as Variational iteration method, Modified differential transform method and Homotopy analysis method and so on.

Several researchers have been trying to solve nonlinear systems possessing low nonlinearity. As the small parameter takes a vital role in the PM. This parameter decides the accuracy and the validation of the PM.

2. HOMOTOPY PERTURBATION METHOD

He [10] proposed a technique namely hompotopy perturbation which is a amalgamation of traditional PM and homotopy. In employing this technique, the required solution is treated as a sum of an infinite series. Besides this infinite series converges to the exact solution rapidly. A large number of different LDE and NonLDE can be solved by using HPM. To illustrate the Homotopy method let us choose a NonLDE

$$E(x)+g(s)=0,\ s\in\Omega \quad (1)$$

With boundary conditions

$$F(x,\partial x/\partial n)=0,\ s\in\Gamma \quad (2)$$

Symbol	Description
E	GENERAL DIFFERENTIAL OPERATOR
F	BOUNDARY OPERATOR
x	ANALYTIC MAPPING
s	DOMAIN'S BOUNDARY

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E is divided into P and Q where Q and P are nonlinear and linear respectively. Therefore (1) is put as

$$P(x)+Q(x)-g(s)=0 \quad (3)$$

Liao (1) presented his homotopy technique as given below .He, built a homotopy as

$y(s,q)$ maps $\Omega[0,1]$ to $\Re$ following,

$$H(y,q)=P(y)-P(z_0)+qP(z_0)+q[Q(y)-g(s)]=0 \quad (4)$$

q is embedding parameter,

q lies between 0 and 1,

z_0 is the starting approximation of (1)

Boundary conditions are satisfied by q and z_0

$$(4)\Rightarrow H(y,0)=P(y)-P(z_0) \quad (5)$$

$$H(y,1)=E(y)-g(s)=0 \quad (6)$$

The two process of variations namely "q moves from 0 to 1" and "q moves from z_0 to $z(s)$" are one and the same and this phenomenon, in TOPLOGY, is depicted by DEFORMATION.

Besides $E(y)-g(s)$ is called homotopic. The embedding parameter is introduced in such a way that it is not effected by any feigned factor and it is treated for minute parameters $q\in[0,1]$. Then solution of the equation (4) is written in specific form as

$$y=y+qy_1+q^2y_2+..... \quad (7)$$

The nearest solution of equation (1) is given by

$$z=\lim_{q\to 1} y=\sum_{i=0}^{\infty} y_i \quad (8)$$

3. ILLUSTRATIVE EXAMPLES

Example-1

A simple example of electrical circuit is a charged capacitor C connected to a coil of N turns wrapped around an iron core. The current (i) versus flux (ϕ) relation for the iron core inductor has the form , In the following Figure 1 there is a electrical circuit which possesses a charged capacitor C and is connected to a coil of N. ϕ and i maintains the following relationship.

$$P_0^{-1}\phi N+\phi^3 E=i \quad (9)$$

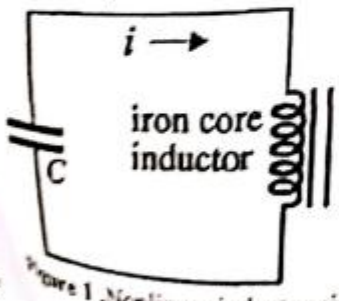

Figure 1 .Nonlinear inductor circuit

If the cube term does not appear then the linear relationship $Q\phi=P_0^{'}$

symbol	Description
P	Coil's own inductance
ϕ	flux

The appearance of iron core generates the cube term. The compact form of the nonlinearity is completely decided by the core's nature.

From Kirchhoff's law one can see

$$qC^{-1}+N\phi'=0 \quad (10)$$

As $i=q'$, by differentiating (10) and considering (9) one can see

$$\ddot{\phi}+\alpha\phi+\beta\phi^3=0 \quad (11)$$

Where $\alpha=\frac{1}{L_0C}$; $\beta=\frac{A}{NC}$;

In the above equation (11) if $\alpha=1$; and $\beta=0.3$ then the equation (11) becomes

$$\ddot{\phi}+\phi+0.3\phi^3=0$$

And by taking the initial conditions as

$$\phi(0)=A \text{ and } \left(\frac{d\phi}{dt}\right)_{t=0}=0$$

Applying the homotopy perturbation method to the equation (11) with the following boundary conditions

$$\phi(0)=A \text{ and } \left(\frac{d\phi}{dt}\right)_{t=0}=0 \quad (12)$$

Now a homotopy $\Omega[0,1]\to R$ is bulid with the following equations

$$P(y)-P(\phi_0)+qL(\phi_0)+qv^3=0 \quad (13)$$

Where $P(\phi)=\ddot{\phi}+\phi$ and $Q(\phi)=0.3\phi^3$

Assuming the initial approximation of equation (1) is of the form

$$\phi_0(t)=A\cos(\alpha t) \quad (14)$$

here $\alpha(\varepsilon)\neq 0$ not known constant and α at 0 is unity. The nearest solution of (3) can put as

$$y=y_0+qv_1+q^2v_2+... \quad (15)$$

And $\phi=\lim_{q\to 1} y=\sum_{i=0}^{\infty} y_i$ (16)

Substituting (15) in (13) & comparing like powers of q

$$P(y_0)-P(\phi_0)=0,\ y_0(0)=A, y_0'(0)=0 \quad (17)$$

$$P(y_1)+P(\phi_0)+0.3y_0^3=0,\ y_1(0)=y_1'(0)=0 \quad (18)$$

From equation (4) we have $y_0=\phi_0=A\cos\alpha t$

Then from the equation (18) we have

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$$\frac{d^2y_1}{dt^2}+y_1+(-\alpha^2+1+0.9\frac{A^2}{4})A\cos\alpha t+\frac{0.3A^3}{4}\cos 3\alpha t=0 \quad (19)$$

Solving the equation (19) one gets

$$v_1(t)=(-\alpha^2+1+\frac{0.9A^2}{4})\frac{A}{(\alpha^2-1)}\cos\alpha t+\frac{0.3A^3}{4(9\alpha^2-1)}\cos 3\alpha t \quad (20)$$

To remove the secular term this can occur in the coming computations, we put α equals 0. Then the first order approximation for the equation (19) is

$\phi(t)=y_0(t)+y_1(t)$ Then we have

$$\phi(t)=\frac{0.9A^3}{4(\alpha^2-1)}\cos\alpha t+\frac{0.3A^3}{4(9\alpha^2-1)}\cos 3\alpha t \quad (21)$$

In (15) when A=1, then the solution becomes

$$\phi(t)=0.99255\cos(1.10756)t+0.01117192\cos(2.72025)t \quad (22)$$

3.1 Generation of phase diagram

The restoring force function in the equation of motion (1) considering $\alpha=1$ and $\gamma=0.3$ is

$$f(\phi)=\phi+0.3\phi^3, \quad (23)$$

Which is a cubic polynomial. For both +ve and –ve amplitudes. The nature of oscillations is one and the same. DE (1)'s singular point is the phase diagram (i.e ϕ' versus ϕ curve) obtained from the roots of $g(y)$ is (0,0). The derivative of he behavior of $g(\phi)$ wrt ϕ is $g'(\phi)=1+0.3\phi^2$ and $g'(0)=1+0.3\phi^2$ and $g'(0)=1>0$ which implies that the singular point (0,0) becomes a centre. If $g'(\phi^*)<0$ then ϕ^* is a saddle point. In the present problem there is no saddle point and hence no separatrix formation. This implies that there is no boundary formation between the stable ad unstable regions of the motion of the oscillator.

Define the potential energy function,

$$I(\phi)=\int_0^{\phi} f(\xi)d\xi=\frac{\phi^2}{2}+\frac{0.3\phi^4}{4},$$

(which implies that $\frac{dI}{d\phi}=f(\phi)$), the equation of motion (1) can be written in the form

$$\frac{d^2\phi}{dt^2}+\frac{dI}{d\phi}=0 \quad (24)$$

Multiplying equation (24) by $2\dot{\phi}$ and applying the initial conditions (2), one gets after integration

$$(\dot{\phi})^2-1+2\{I(\phi)-I(0)\}=0 \quad (25)$$

Equation (25) for the DUFFING equation of motion (1) with the starting conditions (2) are written by

$$(\dot{\phi})^2=1-\phi^2-0.15\phi^4 \quad (26)$$
$$=(1+0.13246\phi^2)(1-1.13246\phi^2)$$

Equation (26) represents the phase diagram (i.e., $\dot{\phi}$ versus ϕ) for the differential equation (1) with initial conditions (2). $\dot{\phi}$ Versus ϕ plot generated from equation (26) shows closed boundary, which implies the existence of the periodic solution. Equation (26) gives equal magnitude of the positive and negative amplitudes (i.e. $\phi=\pm 0.9397, \dot{\phi}=0$).

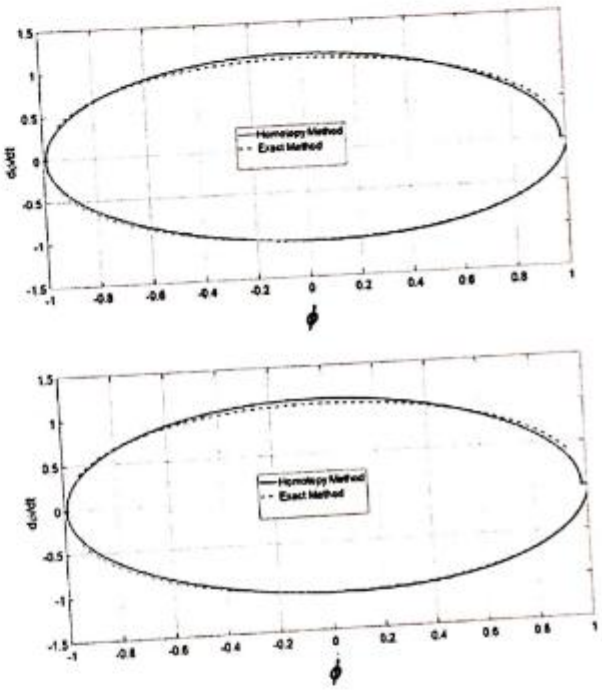

Figure 2. Comparison of the Phase diagram for the solutions obtained by the Homotopy method to the exact method

Example 2:

Suppose there is a curved glass tube and a ball bearing oscillates in it. We know that the restoring force completely depends on the displacement's cube. We neglect frictional losses here. The controlling expressions are

$$\frac{dz}{dt^2}+cz^3=0$$

Where c=1

At t=0 and distance u_0 the ball bearing falls from rest and the auxiliary parameters

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$$z(0)=A,\ \frac{dz}{dt}\ is\ zero\ at\ t=0$$

Whineray built a mechanical oscillator and in that the restoring force is almost close to the proposition of displacement's cube. He constructed, with springs, an air track oscillator which is linear. Here the springs are put at right angles to route rather than on it. This can demonstrate effectively the principles of the cube law oscillators. By applying the homotopy method to the above equation it is modified as

$$\frac{d^2z}{dt^2}+z=z-z^3 \text{ with}$$

$$z(0)=A\ and\ \frac{dz}{dt}=0\ at\ t=0$$

We consider $\Omega[0,1]\to R$ satisfying

$$P(y)-P(z_0)+qP(z_0)+qy^3=0 \qquad (27)$$

Where $P(z)=\frac{d^2z}{dt^2}+z$ and

$Q(z)=0.3z^3$ Assuming the initial approximation of equation (1) as

$$z_0(t)=A\cos(\alpha t) \qquad (28)$$

Where $\alpha(\delta)\neq 0$, unknown, constant, $\alpha(\delta)=0$.

The nearest solution of equation (3) is put as

$$y=y_0+qy_1+q^2y_2+... \qquad (29)$$

$$z=\lim_{q\to 1} y=y_0+y_1+y_2+.... \qquad (30)$$

Put (15) into (13) and compare the expressions with equal powers of q, one can see

$$P(y_0)-P(z_0)=0,\ y_0(0)=A, y_0'(0)=0 \qquad (31)$$

$$P(y_1)+P(z_0)=y_0-y_0^3, \qquad (32)$$

$y_1(0)$ *and* $y_1'(0)$ *are zeros*

From (4) one can see $y_0=z_0=A\cos\alpha t$,then from the equation (18) we have

$$\frac{d^2y_1}{dt^2}+y_1+-A\alpha^2\cos\alpha t=-\frac{A^3}{4}\cos 3\alpha t-\frac{3A^3}{4}\cos\alpha t \qquad (33)$$

Solving (32) one can see

$$y_1(t)=\left(\alpha^2-\frac{3A^2}{4}\right)\left(\frac{A}{(-\alpha^2+1)}\cos\alpha t-\frac{A^3}{4(-9\alpha^2-1)}\cos 3\alpha t\right) \qquad (34)$$

Secular expression might come in the foregoing iterations. To remove this makes the cost's coefficient as

$$\alpha=\sqrt{\frac{3A^2}{4}}$$

Then the first order approximation for the equation (27) is

$$z(t)=y_0(t)+y_1(t)$$

Then we have

$$z(t)=A\cos\alpha t+\frac{A^3}{4}\frac{1}{(9\alpha^2+1)}\cos 3\alpha t$$

If we put A=1 then

$$z(t)=\cos 0.8660t+0.0322\cos(2.598)t \qquad (35)$$

3.2 Generation of PHASE DIAGRAM

To study the fit of the SOLUTION (35) of the truly NLODE, the phase diagrams are to be constructed. Figure1 depicts the differences between PHASE DIAGRAMS come out of equation (7), (28).The true value of dz/dt are plus or minus 0.7071 at the instant u is zero. But from the modified differential transform method y' values are computed as -0.850 and 0.9393 respectively. There are known to be distinct in their magnitudes for the particular greatest +ve amplitude of units the real PHASE DIAGRAM depicts the –ve amplitude as minus1.

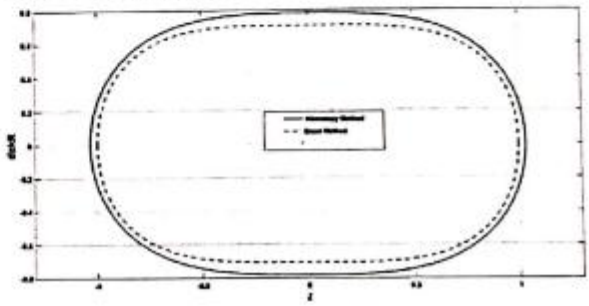

Figure 3. Comparison of the Phase diagram for the solutions got by HPM and the formal method

4. CONCLUSION

The solutions got by HPM for above two applications, have coincidence with the solutions obtained by the direct method. For the first example the solution obtained by the homotopy method is close to the solution obtained by the direct method whereas for the second example the solution is near to the exact solution. Hence the homotopy method is able to provide the periodic solutions of the nonlinear differential equations. Appendixes, if needed, appear before the acknowledgment.

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Application of Homotopy Analysis Method for Investigating Nonlinear Oscillations

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ABSTRACT

Homotopy Analysis Method (HAM) is a well organized method to get the periodic solution of Non-Linear Oscillatory Duffing Equation of Motion. By having a glance on Helmholtz Equation of Motion an attempt has been made to explore the proficiency of HAM. This research article explores on Helmholtz Equation of Motion possessing non-odd restoring force function. Moreover in this equation the behavior of oscillations is different for the same magnitude of +ve and –ve amplitudes. This phenomenon concerns with asymmetric oscillations which are nonlinear. In the case of large amplitude vibrations a greater amount of inconsistency has been noticed here. Furthermore the incapability of HAM in differentiating the non-periodic solution of Motion has been extensively discussed.

Key words : Homotopy Analysis Method (HAM); Duffing Equation; Helmholtz's equation of Motion (HEM) ; Periodic solution; Phase-plane diagram, Differential Equation (DE)

1. INTRODUCTION

A larger number of problems in Engineering Sciences are modeled by Non-Linear Duffing Equation of Motion namely

$$\frac{d^2x}{dt^2} + g(x) = G(t) \qquad (1)$$

Here restoring force function which is a polynomial is given by

$$g(x) = ax + bx^3 + cx^5 + \ldots + dx^m \qquad (2)$$

G (t) =Forcing Function (Periodic)

Here stiff constant is a.

b, c,..d are parameters.

$m \in \{1,3,5,\ldots\}$.

(2) is an odd function so that one can expect oscillations which are symmetric. To the equation of motion or a harmonically forced undamped single degree of freedom oscillator, Helmholtz added the nonlinearity. The behavior of the eardrum is like an asymmetric oscillation with restoring function

$$g(x) = a_0x + a_1x^2 \qquad (3)$$

The Helmholtz equation of motion is

$$n\frac{d^2x}{dt^2} + a_0x + a_1x^2 \qquad (4)$$

Khatami et al. [1] presented general solutions for Duffing oscillations which are not linear with 5^{th},6^{th} and 7^{th} degree polynomial odd restoring force functions. They incorporate DTM and received fruitful results. In the case of an odd degree polynomial restoring function with symmetric oscillations of the system this method can give good results. But in the case of non-odd restoring force functions with asymmetric oscillations uncertainties are observed. In this scenario a large number of researchers made an attempt by adopting HPM in order to crack many DEqs. The primary goal of this talk is to test the acceptability HPM for Duffing Oscillators with non-odd restoring force function

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2. HOMOTOPY ANALYSIS METHOD

HEM is

$$\frac{d^2x}{dt^2}+x+\nu x^2=0 \qquad (5)$$

$$x=B,\ \frac{dx}{dt}=0 \ \text{ at } t=0 \qquad (6)$$

ν = nonlinearity of x.

B= Amplitude of x.

In the light of Liao [10], the HAM is applied to the NLDE (5) and a Homotopy namely d $\Omega\times[0,1]\to R$ is introduced and follows

$$q[N(x)+L(x_0)]-[L(x_0)-L(x)]=0 \qquad (7)$$

Here $L(x)=\frac{d^2x}{dt^2}+x$ and $N(x)=\nu x^2$

(7) is approximated with

$$x=x_0+qx_1+q^2x_2+... \qquad (8)$$

And $w=\lim_{q\to 1}x=x_0+x_1+x_2+....$ (9)

Put (8) in (7) and by making comparison we can have

$$L(x_1)+L(x_0)+\nu x_0^{\ 2}=0 \qquad (10)$$

$$L(x_2)+2\nu x_0x_1=0 \qquad (11)$$

$$L(x_3)+2\nu(x_1^{\ 2}+x_0x_2)=0 \qquad (12)$$

Let the beginning approximation (5) be

$$x_0(t)=B(COS(\alpha t)) \qquad (13)$$

$$L(x_0)=B(COS\alpha t)(1-\alpha^2) \qquad (14)$$

$\alpha(\nu)$ is fixed and not equal to 0 and its value at 0is 1.

(10) is simplified as

$$\frac{d^2x_1}{dt^2}+x_1+(1-\alpha^2)B(COS\alpha t)+0.5B^2\nu+0.5B^2\nu COS2\alpha t=0 \qquad (15)$$

The solution of (15), gives

$$x_1(t)=\left(B+0.5B^2\nu+0.5B^2\nu(1-4\alpha^2)^{-1}\right)COSt-BCOS\alpha t-0.5B^2\nu-0.5B^2\nu(1-4\alpha^2)^{-1}COS2\alpha t \qquad (16)$$

The secular term in (16) is eliminated by setting

$$B+0.5B^2\nu+0.5B^2\nu(1-4\alpha^2)^{-1}=0$$

$$\Rightarrow\alpha=0.5(SQRT(1+B\nu)/(1+0.5B\nu)) \qquad (17)$$

α *is* 0 *gives* $1+B\nu=0 \Rightarrow B=-(\nu)^{-1}$

First Order Approximation to (9) is given by

$$x(t)=x_0(t)+qx_1(t)$$

Now

$$x(t)=BCOS\alpha t+q\left[-BCOS\alpha t-0.5B^2\nu-0.5B^2\nu(1-4\alpha^2)^{-1}COS2\alpha t\right] \qquad 18)$$

At $q=1$

$$x(t)=-0.5B^2\nu+\left(B+0.5B^2\nu\right)COS2\alpha t \qquad (19)$$

For B=1 & $\nu=0.1$ (19) is

$$x(t)=(1.05)COS(1.02353t)-0.05 \qquad (20)$$

(19) gives

$$\frac{dx}{dt}=\left(((1+B\nu)/(1+0.5B\nu))(B-x)(B+B^2\nu+x)\right)^{\frac{1}{2}}$$

numerically. (21)

This is used in comparing the results with actual solution.

3. PHASE DIAGRAM GENERATION

To create PHASE DIAGRAM, one can see the relation as $\left(\frac{dx}{dt}\right)^2=\left[(B+x)+\frac{2\nu}{30}\left(B^2+Bx+x^2\right)\right](B-x)$ by(5) (22)

The PHASE DIAGRAM of DE (5) with boundary condition (6) is represented by the plot of $\frac{dx}{dt}$ Vs x. For B=1 and $\nu=0.1$ the plot of $\frac{dx}{dt}$ versus x created from (21) depicts a boundary which is closed. From (22) the magnitude of +ve amplitude of Non-Linear Oscillations is 1. From (22) the magnitude of –ve amplitude of Non-Linear Oscillations is -1.0717. This gives asymmetry of the PHASE DIAGRAM w.r.t $\frac{dx}{dt}$ axis, whereas it is symmetric w.r.t x-axis. (1) describes the PHASE DIAGRAM created from (22) and it shows magnitudes of +ve and -ve amplitudes which are unequal.

At B=1 and $\nu=0.1$ the singularities are origin and (-10,0). Origin is the singular point. (-10, 0) is the saddle point. In

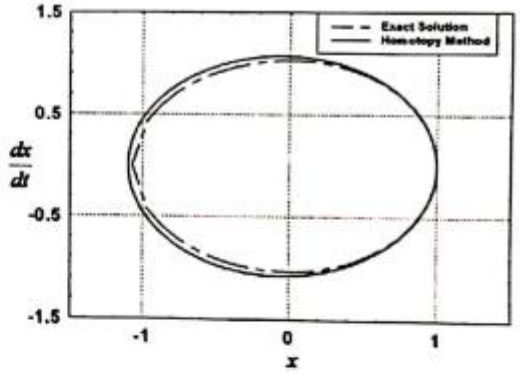

Figure 1. Helmholtz equation Vs exact solution

In order to get the periodic solution the range of amplitudes should lie in the interval (-10, 5).The periodic solution is impossible Out-side of this range.

In Fig.2, 3, 4, 5; the PHASE DIAGRMS are created for $B\in\{2,4,5,6\}$ and $\nu=\frac{1}{10}$. More over these are being compared with HOMOTOPY METHOD's solution. PHASE DIAGRAM concerning with x(0)=5 stands for the separatrix.

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the case of x(0)=1 It stands for the boundary which is losed and possessing periodicity. PHASE DIAGRAM reated for x (0) =5 by using (21) is possessing close nagnitudes of +ve & –ve amplitudes. Here the separatrix tands for the big amount of difference in the magnitudes of -ve & -ve amplitudes. The HOMOTOPY solution stands exactly close to the domain at the particular boundary constraints. Fig.6 & 7 depict distinct PHASE DIAGRAMS rom (21) and (22). HOMOTOPY METHOD is incapable to differentiate non-periodic &periodic behavior of the solutions.

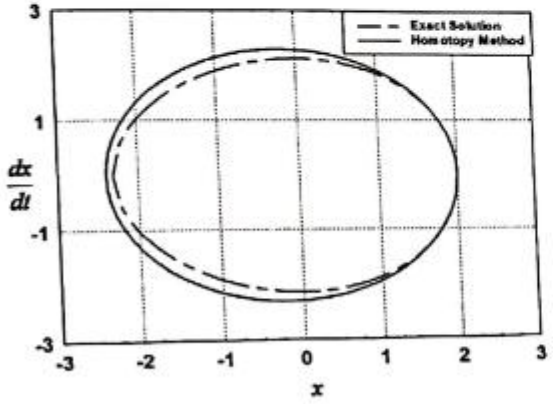
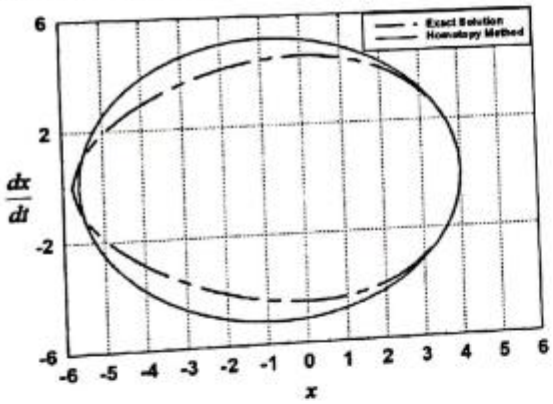


Figure 2. Comparing the PHASE DIAGRAMS for x(0) =2



Fiure 3. Comparing the PHASE DIAGRAMS for x (0) = 4.

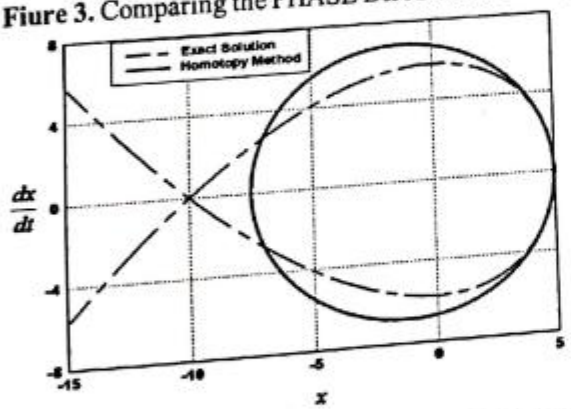


Figure 4. comparing the PHASE DIAGRAMS generated for x (0) =5

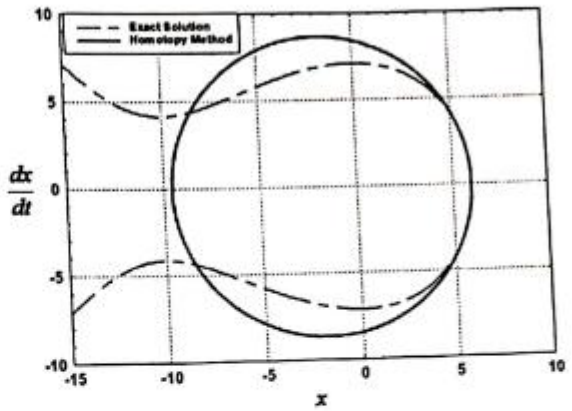


Figure 5. Comparing the PHASE DIAGRAMS for x (0) =6

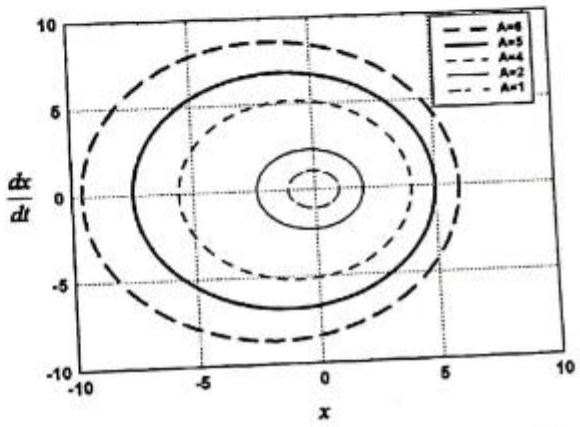


Fig. 6: PHASE DIAGRAMS generated for different amplitudes obtained by the Homotopy analysis method

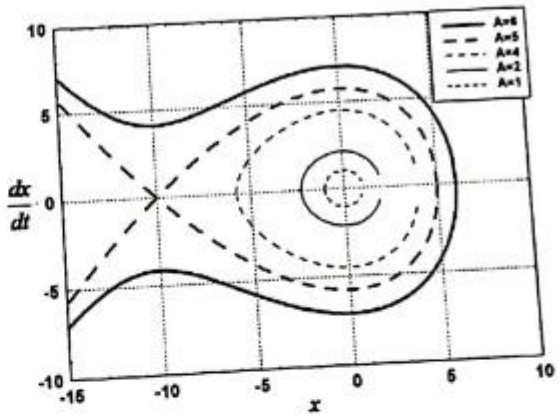


Fig.7: PHASE DIAGRAMS created out of exact solution for various amplitudes

4. CONCLUSION

The capability of the Homotopy Analysis Method is investigated by observing the nonlinear oscillations of Helmholtz Equation of Motion. Large discrepancy is observed

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in magnitudes of positive and negative amplitudes using the Homotopy Analysis Method in case of large amplitudes. Therefore Homotopy Analysis Method is incapable to differentiate non-periodic and periodic solutions. In the case of B exceeding 5 and $\nu = 0.1$, phase plane diagram obtaining by exact solution is not closed and depicts non-periodic nature, whereas the Homotopy Analysis Method gives the closed phase plane diagram (i.e., periodic) for all values of B. Hence, Homotopy Analysis Method is incapable to differentiate the non-periodic solutions.

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A STUDY ON EFFICIENCY OF WORKING CAPITAL MANAGEMENT WITH SPECIAL REFERENCE TO MICRO AND SMALL ENTERPRISES IN CHITTOOR DISTRICT OF ANDHRA PRADESH

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ABSTRACT

Working capital employed in MSMEs is financial metric which tells about the liquidity available and also indicates the financial health of an enterprise. Working capital has two major components – current assets and current liabilities. The efficiency with which an enterprise operates dependents exclusively on how that enterprise utilizes the working capital and manages its different sub-components. The research carried out so far did not deal with the each of these components of these two major components and explain that inefficient management of working capital was responsible for their losses and closing up the enterprises with high amount of NPAs. Though a number of studies that dealt with management of working capital have focused on macro picture at state or national levels. The specific field-based studies that have evaluated the efficiency of managing the working capital in MSMEs at district level are scanty.

Keeping this research gap in view, the present study focuses on the evaluation of management of working capital in Micro and Small Enterprises (MSEs) in Chitroor district. Exclusively based on primary data collected by canvassing a structured and pre-tested questionnaire and the financial statements prepared by the enterprises selected, the present paper deals with an analysis of working capital employed and how it is utilized, in sample Agro, food and allied enterprises(36), Textile-based enterprises (34) and Mineral-based (30) enterprises operating in Chittoor district.

Primary data for these 100 sample enterprises was collected for a period of 6 years i.e. from 2011-12 to 2016-17 and assessment was carried out with the help of Ratio Analysis and Liquidity Index .The primary objective is to evaluate how efficiently the sample enterprises were able to manage the working capital invested with each of their respective enterprises. By this evaluation, the present paper satisfies the objective of district level research studies on

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management of working capital, with all its sub-components , which are absent particularly with reference to Chittoor district and represents a bench mark attempt to carry out further research embracing the other dimensions of working capital management.

Key Words: Micro and Small Enterprises, Working Capital, Current Assets, Current Liabilities, Inventories, Trade Receivables, Liquidity Index.

INTRODUCTION:

Capital, the vital financial propeller that activates the production activity by establishing a symbiotic relationship among all the factors of production, specifically for an economic activity. Capital is the factor production necessary for the employment of labor, particularly in industrial sector, in association with land, ignites the production process with its suitable structure. It is so important for micro, small and medium enterprises for their efficient operation in the present complex production-environment and also to stay as competitive enterprises in the global market conditions. Getting adequate profits are the primary objective of any enterprise, adoption of a suitable capital structure assumes much importance in any economy, where in MSMEs are considered as a strategic option for income and employment generation with less amount of capital. Today, much research was carried out to prove the fact that MSMEs serve as a suitable development strategy for providing sustainable development opportunities in the available locally, which results into acceleration of regional industrial development. It was also argued that MSMEs are the activities that facilitated the development of entrepreneurship by reaping the external benefits, innovation and labour productivity.

Working Capital and MSMEs

The capital structure of MSMEs basically includes two broad and major components- Fixed capital and Financial (Working) Capital. The first component includes physical capital and the latter component includes current assets and current liabilities, which is generally called as Working Capital. Working Capital a vital component of capital employed, which helps to convert raw material into finished goods up to the cash realization. The concept of present "Working Capital" is nothing but the concept of "Variable Capital" used by classical economists.

Working capital employed in MSMEs is called as a financial metric, representing the operating liquidity available to an enterprise and represent a portion of operating capital. The

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amount of working capital is treated as an index of financial health of an enterprise. Keeping in view the general methods of calculations, working capital consists two major components- current assets and current liabilities. Based on these components working capital is defined as "the current assets over current liabilities. A balanced approach is required between these two major components. In the modern days a financial manager of any enterprise strives to find out a cheapest and convenient source of financing these components and also to keep an optimum mix of current assets and current liabilities. Hence, MSMEs consider the working capital, the singular source, to meet the short term financial requirements and refer to it as "trading capital". For an enterprise, working Capital is equal to the blood in circulation for a human being and if it becomes weak, there is a room forgetting lower or nil profits and the enterprise many not survive. The enterprise must be capable of generation of cash receipts in excess of its payments, then only it will have adequate liquidity to meet the day to financial requirements. All these inter relationships makes it clear that an efficient working capital administration assumes a critical process of the financial management of an enterprise. This process of administration / management deals with the management of ingredients of current assets and current liabilities in an enterprise, because there is a positive link between efficient management of working Capital and profitability (Eyelly A MA(2004) Pedro, J.G and Pedro M (2007), karaduman, H, (2011). An enterprise has to manage its inventories, receivables and payables for its success and to eliminate the risk of inability to meet short term obligations also to avoid excess investment in assets for maintaining a balance between risk and efficiency.

Need for efficient Working Capital

The research put forth on the system of efficient management of working capital and operational success of MSMEs makes it clear that working capital management is one of the most vital segments of financing decisions and a dynamic stimulus for its good performance managing the problems that arise towards the maintenance of current assets and liabilities at optimum level is the important purpose of management of working capital. The interrelation that exists in between current assets and liabilities is to be carefully observed so that working capital is neither inadequate nor excess of what is required. Maintenance of this equitable balance in between the components of Working Capital exerts a telling effect on profitability liquidity and financial health of an enterprise. An efficient management of working capital in an enterprise

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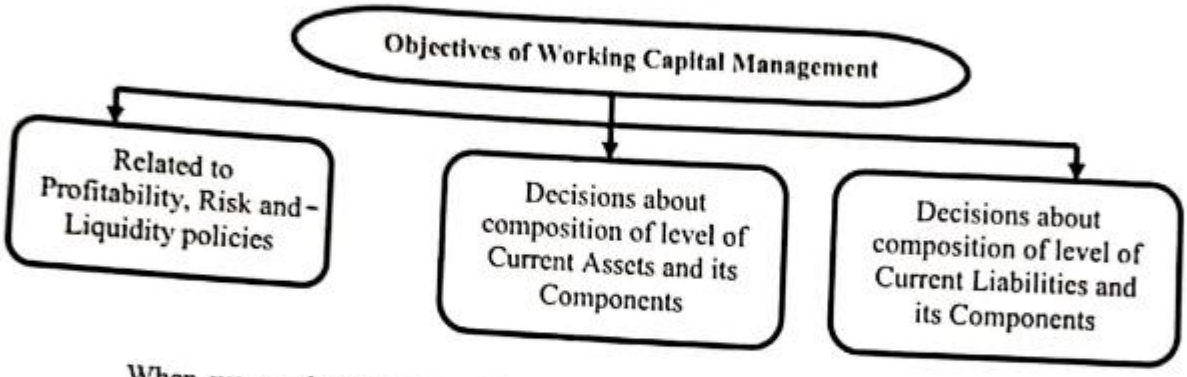
specifically serves the following three important objectives of working capital. Three objectives of Working capital Management



When we go through these objectives, we can understand that holding too much of current assets (liquidity) leads to reduction in risk at cost of decreased profitability. An enterprise must operate on the principles of speeding up collections (Trade Receivables) as quickly as possible to pay the disbursements (current Liabilities) to minimize the risk. This is the trade off that exists between profitability and risk, which is the main purpose of management of working capital. If an enterprise fails to pay its obligations results into loss of its reputation and it is also true that inadequate inventories leads to held up of production and may lead to purchase of raw materials at higher prices. Working capital available with an enterprise should provide a cushion in bad days and avoid interruption in the process of production and generate sufficient funds to finance inventories and payments to be made. Hence, it was said that proper management of working capital is the driving seat of a financial manager or owner of an enterprise.

Review of Literature

The foregoing discussion makes it clear that the management of working occupies an important place in the business finance, particularly for MSMEs in any economy. In the present study an attempt is made to an insightful analysis of working capital management in MSMEs, with specific reference to total current assets and liabilities and with reference to their sub-components by using Ratio Analysis. It is to be accepted that a number of research was carried out based on the subject of management of working capital in developed and developing countries and in India also.

A field survey conducted by Hemanth Saikia (2012) in Assam with a sample of 220 small scale industries, dealt with the measurement of financial performance of SSIs. Her research

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observed that mobility of inputs was small; management of quality of the labour input was not good. There was shortage of funds as the native investors have faced difficulties in raising the funds. Siddarapu Haribabu and prof. M. Venkatewarlu (2019) have discussed the socio-economic conditions of MSMEs in YSR Kadapa district and Chittoor district of Andhra Pradesh. Dr. Nallabala Kalyan (2017) made an attempt to analyze the performance of MSMEs in Chittoor District. He analyzed the capital –output-ratio input output ratio of MSMEs in Chittoor district tested by ANOVA and T-test techniques the problems and prospects_of MSMEs in chittoor district was presented by Dr. Nallabala Kalyan and Hareesh babu(2017) and suggested some measures for smooth and accelerated growth of MSMEs in chittoor district. N. Venkataramana et.al (2013) have made an attempt to find out the efficiency of receivables management and its impact on working capital management and also to assess the impact on Working Capital Management on profitability in the selected cement companies in India. They have used financial tools like ratio Receivables to current ratio, Receivables to total assets ratio and receivables to sales ratio. They have came to a conclusion that receivables management was not satisfactory and the average collection period across industry was less than the suggested norms. P. Seshagiri Rao (2014) aimed at a study of need for promoting SSIs and its role in development and on examination of the problems of small and medium enterprises in Chittoor district. D. Sudarsana Murthy (2016) published a research paper on the analysis of performance evaluation of MSMEs in Chittoor District of Andhra Pradesh. He has observed that entrepreneurs were found facing the problems related to production, finance, marketing and other related areas of management.

The Need for present Study

The analysis of references presented above related to MSMEs in Andhra Pradesh and in Chittoor District proves the fact that the studies that have dealt with the total current assets and liabilities comprising their respective sub-components of MSMEs were not available. Keeping this research gap in view, and to present a district-specific study on working capital management in Micro and Small Enterprises, an attempt is made to analyze the management of working capital in MSMEs in Chittoor District.

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Chittoor District: The Study Area:

Constituted on 1st April, Chittoor is the southernmost district of Andhra Pradesh. It is one of the drought prone districts of Rayalaseema region. Chittoor district receives an inadequate rainfall and of the 66 revenue mandals, most of the mandals are announced as drought prone mandals every year. Since there are no perennial rivers in the district, 1,16,239 wells form the major source of irrigation. 70.5 per cent of the total population resides in rural areas and the urban population accounts for 29.5 per cent (2011 Census). The literacy rate worked out to 71.5 per cent. The district has a good bank-branch network, since 580 bank branches are operating in the district, serving 7197 persons per bank branch.

Agriculture is the primary occupation in the district, as 61.2 per cent of the total workers are dependent on agriculture sector as cultivators and agricultural labor. 38.8 per cent of the workers are engaged in household industries and other household industries (MSMEs). The industrial structure of the district comprises a combination of both large and mega industries and MSMEs. As on 2015-16, 113 large and mega industries wee enlisted providing employment to 37090 persons with a capital investment of Rs.778077.2 lakhs. As a supplementary structure, it was estimated that 3588 MSMEs are operating in the district, providing employment to 50,421 persons with a capital investment of Rs.2,30,373 lakhs. (General Manager, DIC). These statistics reveal that with a capital investment of Rs.4.61 lakhs on an average per enterprise, MSMEs are capable of providing employment to 14.1 persons. On the contrary, the large and mega industries need Rs.21 lakhs on an average to provide employment to one person, which works out to Rs.32, 929 for MSMEs for generating employment to one person. Hence, it is evident that MSMEs in the district are capital-light in nature with comparative high employment-potentiality and forms the important source of income and employment, after agriculture sector.

Methodology and Tools of Analysis:

The present study is based on primary data collected from 100 micro and small enterprises in Chittoor district. The data was collected by canvassing a structured schedule designed to collect the relevant information covering working employed in total assets and liabilities for 6 years period i.e. from 2011-12 to 2016-17. The data was collected during the months of July to August, 2019 by visiting the sample enterprises selected.

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Sample Size:

The selected 100 micro and small enterprises selected represent three major categories of enterprises viz.. Agro, food and allied enterprises (36), Textile-based enterprises (34) and Mineral-based enterprises (30). Stratified Random sampling technique was adopted to select the sample enterprises.

Tools of Analysis:

The primary data collected was processed and analyzed with the help of Ratio Analysis. Current Ratio, Quick Ratio, Working Capital Turnover Ratio, Debtors Turnover Ratio and Cash Position Ratio were measurement metrics used for the analysis. Ratio analysis assumes much importance to evaluate the financial performance of sample micro and small enterprises to get clues of efficient management of working capital over a period of time. This method of analysis helps to make a qualitative judgment about the liquidity, profitability and to present a comparative inter-category of sample enterprises. The types of ratios used, their formulae and the purpose of the ratios used is briefly presented in Table.1

Table. 1. Types of Ratios Used for the Analysis

S. No	Measurement Metrics Used	Formula	Objective of the Measurement
1	Current Ratio	$\frac{\text{Current Assets}}{\text{Current Liabilities}}$	Measures Short term financial strength
2	Quick Ratio	$\frac{\text{Quick Assets}}{\text{Current Liabilities}}$	Measures the ability of the enterprises to meet shot term obligations
3	Working Capital Turnover Ratio	$\frac{\text{Sales}}{\text{Working Capital}}$ (times)	Determines the efficiency with which working capital is utilized
4	Debtors Turnover Ratio	$\frac{\text{Sales}}{\text{Debtors}}$	Determines the efficient management of Trade Receivables.
5	Cash Position Ratio	$\frac{\text{Cash and Cash equivalents}}{\text{Total Current Liabilities}}$	Determines the ability to pay debt obligations

Besides, the use of above mentioned ratios, an attempt is also made to calculate the "Liquidity Index" by using the following formula:

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(Trade Receivables x Days to Liquidate)+ (Inventory x Days to Liquidate) / (Trade Receivables+ Inventory).

Objectives of the Study:

Analyzing the efficient management of working capital employed in sample enterprises is the basic objectives of the present paper. In addition, the present paper makes a modest attempt to satisfy the following primary objectives also:

1) To analyze the Liquidity Position of the sample enterprises
2) To estimate the turnover ratios to assess the performance of sample enterprises
3) To calculate Liquidity Index to determine how the sample enterprises are able to quickly raise cash to pay its liabilities.

Results and Discussion:

Socio-economic Features of Owners of Sample Enterprises:

The data collected reveal that majority of the owners of the sample enterprises belong to Chittoor district (72.6 per cent) and others to YSR Kadapa and Anantapur districts of Andhra Pradesh. Majority of the owners belonged to backward classes, (47.8 percent), Other social groups (29.4 per cent) and socially disadvantaged sections (22.8 per cent).79.0 per cent of the enterprises were proprietary in nature and 54.8 per cent of the owners had technical education as their qualifications and 22.9 per cent of the owners were commerce and economics graduates. A proportion of 44.8 per cent of the enterprises had own premises and others were found operated in rented premises. Majority of the owners (55.6 per cent) belonged to the age group of 33- 48 years and 34.6 percent belong the age group of less than 33 years. Most of the owners (67.9 per cent) had previous experience in the same category of enterprises and 27.8 per cent of the owners ventured to start the sample enterprises to prove their entrepreneurial skills and capabilities.

Working Capital and its Management:

It is quite evident that the important objective of management of working capital is nothing but ensure liquidity and inadequate attention towards this purpose makes the enterprises unable to meet the obligations, which results into the lack of loyalty. Besides, if the funds are tied up in working capital, earnings or returns are negatively influenced for an enterprise. Therefore determining an optimum level of amount of Working cap[ital assumes much importance for the maintenance of financial health of the enterprises. To understand all these

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effects, an attempt is made to estimate the following important ratios, to find out the financial health of the sample enterprises.

Ratio Analysis:

1. Current Ratio:

The proportion of current assets to current liabilities measures the working capital available during the reference period of 6 years i.e. from 2011-12 to 2016-17. The details of ratios calculated for sample agro-food and allied enterprises are presented in Table.2

Table. 2. The Calculations of Ratios for Agro, Food and Allied Enterprises

Reference Period	Ratios Calculated				
	Current Ratio	Quick Ratio	Working Capital Turnover Ratio	Debtors Turnover Ratio	Cash Position Ratio
2012	1.19:1	0.70:1	9.17	5.1	0.30
2013	1.21:1	0.65:1	8.99	5.4	0.24
2014	1.19:1	0.65:1	8.16	4.9	0.27
2015	1.25:1	0.72:1	6.75	4.9	0.29
2016	1.25:1	0.73:1	6.75	4.9	0.30
2017	1.41:1	0.85:1	3.93	3.8	0.34

Source: Field Survey and Preparation of Financial statements of selected enterprises.

It is evident from the calculations of current ratio that the proportion of current assets in agro, food and allied enterprises to current liabilities has been increasing. It is well known that 2:1 is considered as satisfactory ratio; however the current rajio worked out to 1.19:1 to 1.41:1 during the reference period. This position of current ratio indicates some difficulty of the sample enterprises to meet the current obligations. However, it is also evident that the sample enterprises did not keep high level of current assets (> 2), which did not result in the idle funds.

The quick ratio represents a standard of liquidity as the ratio does not include inventories. . It is well known that 1:1 is considered as satisfactory ratio; however the quick ratio worked out to 0.65:1 to 0.85:1 during the reference period. This position of quick ratio indicates the unsatisfactory level of liquidity for the selected agro, food and allied enterprises.

The data on calculated Working capital turnover ratio reveals that the ratio shows a declining trend during the reference period from 9.17 times to 3.93 times. This ratio shows ability of an enterprise to generate income per rupee of working capital employed. The calculated ratio for the study period reveals the inefficiency of the sample enterprises to utilize the working capital, as the values for the ratio is found declining during the study period.

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The Debtors turnover Ratio is calculated by dividing the revenues from sales by average trade receivables. The calculated debtors Turnover ratios indicate a declining trend. This ratio was 5.10 times during the year 2012 and has declined to 3.80 times during the year 2017. This declining trend reveals that the quality of trade receivables and the credit collection efforts of the sample enterprises are not at satisfactory level.

The cash position ratio shows the amount of cash and cash equivalents available with the enterprises to meet immediate payments. The calculated values for this ratio indicate an increasing trend during the reference period from 0.30 to 0.34. In spite of this trend the calculated values are found below 1, even the recommended values of 0.5, it can be said that the enterprises need more than just its cash reserves to pay its current liabilities.

Ratio Analysis for Textile Based Enterprises

As mentioned in methodology adopted 34 textile based micro and small enterprises were visited and the financial statements were collected for analyzing the ratios to assess their level of working capital management. The selected ratio were calculated and presented in Table.3.

Table. 3. The Calculations of Ratios for Textile-based Enterprises

Reference Period	Ratios Calculated				
	Current Ratio	Quick Ratio	Working Capital Turnover Ratio	Debtors Turnover Ratio	Cash Position Ratio
2012	1.38:1	0.90:1	4.32	2.66	0.21
2013	1.34:1	0.89:1	4.58	2.58	0.23
2014	1.58:1	1.04:1	3.02	2.59	0.28
2015	1.68:1	1.10:1	2.42	2.34	0.30
2016	1.76:1	1.15:1	2.35	2.42	0.35
2017	1.88:1	1.27:1	1.94	2.36	0.44

Source: Field Survey and Preparation of Financial statements of selected enterprises.

It is evident from the calculations of ratios, as presented in table.3, that both current ratios was less than the standard ratio i.e. 2:1 though it shows increasing trend during the reference period. Though Quick ratio was below the satisfactory ratio i.e. 2:1, though it shows increasing trend during the reference period. Though quick ratio was below the satisfactory level (1:1), during the initial years from 2014 inwards it has exceeded the ideal ratio (1:1) for the

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succeeding years and found high at 1.27:1 for the year 2017. The increasing trend of quick ratio indicates the ability of sample enterprises to meet current obligations without relying on the sale and collection of inventories.

The calculated working capital ratios are found decreasing during the reference period from 4.32 to 1.94 which indicates that the sample enterprises are not efficient to generate revenues from the sales. The debtors turnover ratio, which is an accounting measure the effectiveness of sample enterprises in extending credit and the collection of debt. These calculating ratios ranged from 2.66 to 2.36 times, which indicates a slow process of effective use of their assets. However, the calculated of cash position ratios which ranged from 0.21 to 0.44 with an increasing trend. The stable cash position is not satisfactory to cover the liabilities of the sample enterprises during the reference period. This stable /low ratio might be an indication of liberal and inefficient credit and collection efforts of the sample enterprises.

Ratio Analysis for Mineral Based Enterprises

The data related to financial statements were collected from 30 mineral based enterprises for the calculations of ratios to assess the efficiency in the working capital management of these enterprises. The calculated ratios are presented in Table 4.

Table :4 Calculations of Ratios for sample Mineral-based Enterprises

Reference Period	Ratios Calculated				
	Current Ratio	Quick Ratio	Working Capital Turnover Ratio	Debtors Turnover Ratio	Cash Position Ratio
2012	1.25:1	0.76:1	7.06	5.54	0.15
2013	1.18:1	0.72:1	9.16	5.44	0.14
2014	1.17:1	0.70:1	7.85	4.67	0.14
2015	1.37:1	0.82:1	4.95	6	0.17
2016	1.48:1	0.88:1	3.59	5.44	0.16
2017	1.51:1	0.92:1	3.46	5.64	0.16

Source: Field Survey and Preparation of Financial statements of selected enterprises

The calculated current ratios for sample mineral based enterprises as presented in Table 4 are found below the ideal ratio of 2:1, though the ratio gradually increased from 1.25:1 in 2012 to 1.51:1 in 2017. These ratios indicate the inability of the sample enterprises to meet their current liabilities. Similarly the quick ratio increased from 0.7:1 in 2014 to 0.92:1 in 2017

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which indicates the enterprises are unable to pay the liquid liabilities. The calculated of working capital turnover ratios, show a declining trend during the reference years from 9.16:1 in 2013 to 3.46:1 in 2017 indicating the inability of the sample enterprises to generate income from sales by turnover ratio, as calculated, show the quality of trade receivables and the efforts of credit collection are not satisfactory, since the ratios were found fluctuating ranging from 4.67 in 2014 to 6.00 in 2015. The calculations of cash position ratios, exhibit the financial strength and liquidity of the sample enterprises. These ratios ranged from 0.14 to 0.16 during the reference period, and were found below the satisfactory level. Similarly, the cash position ratio were found very low, which indicates that the cash flows generated by the sample enterprises were insufficient to pay off their current liabilities.

Calculation of Liquidity Index:

An overview of the ratio analysis presented in the foregoing analysis amply reveals the fact that the sample enterprises have to pay much greater attention towards enterprises have to pay much greater attention towards the efficient management of working capital invested in their respective enterprises. It is evident from their financial statements that a large portion of their Gross Working Capital was fastened in inventories and trade receivables, as their proportion was estimated ranging from 68.5% to 74.7% if the gross working capital (Total Current Assets). It seems this proportion of these two components cautions that a major proportion of gross working capital is tied up, which represents a low qualitative management of working capital as well as the liquidity of the sample enterprises. Keeping this attitude towards utilization of working capital an attempt is made to work out the "Liquidity Index" by using the following formula:

$$\text{Liquidity Index} = (AR \times ARCP) + (I \times DL) \div (AR \times I)$$

Where: AR= Accounts Receivables

ARCP = Average Receivables Collection Period (in no of days)

I = Inventories

DL = Number of days to liquidate.

Liquidity Index is a financial indicator which is used to estimate the number of days required to convert the trade receivables and inventory into cash. This index measures the ability of an

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enterprise to generate cash necessary to meet the current liabilities in its business. It shows the capacity of an enterprise to convert accounts receivables and inventories and how quickly the cash is raised to meet the expenses of day-to-day operations.

By using the above said formula, an attempt is made to estimate the values of liquidity index for the three categories of sample enterprises, selected for the present study. The values are presented in Table-5 to provide inter-category capacity of liquidity which explains the assessment of efficient utilization of working capital in general and gross working capital in particular.

Table: 5 Liquidity Index for Sample Enterprises

Reference Period	Category of Sample Enterprises			Mean values for All Sample Enterprises
	Agro, food and allied based	Textile based	Mineral based	
2011-12	37.88	31.86	51.34	40.36
2012-13	37.07	32.08	47.66	38.94
2013-14	39.08	29.19	51.97	40.08
2014-15	38.07	27.36	46.60	37.34
2015-16	38.36	28.53	42.56	36.48
2016-17	39.41	30.07	47.42	38.55
Mean	38.15	30.07	47.42	38.55

Source: Calculated from the financial statements of the sample enterprises.

It is observed from the liquidity index values presented in Table. 5 that textile-based enterprises have the lowest values (30.07), compared to mineral-based enterprises (47.42) and agro-based enterprises (38.15). The mean values for all the sample enterprises ranged from a low of 36.48 (2015-16) to a high of 40.36 (2011.-12). However, the index values are found decreasing during the years of reference, which cautions about the inability of sample enterprises to maintain a stable and /or a satisfactory level of liquidity.

Conclusion:

If we go through the ability of sample enterprises as measured by current and quick ratios, it is found that they are suffering from inefficient management of working capital, except textile-based enterprises from 2013-14 onwards during the reference period. The result of working capital turnover ratio reveals the failure of sample enterprises to generate revenue from the working capital invested during the study period. It is noticed that the quality of trade receivables and the credit collection efforts were not found satisfactory and the cash position ratio was also below the recommended values and unable to pay the current liabilities. The liquidity index values calculated for the study period also revealed that the sample enterprises

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could not able to maintain satisfactory level of liquidity levels and were found unable to raise cash to meet even the short term obligations. The analysis of the above said indicators leads to an inference that the sample enterprises have to pay an increased attention towards inventory, trade receivables management for effective utilization of working capital. It is so important that they have to carefully attentive towards payables, as the average period of collection of payables was found below the satisfactory levels. Above all, they have to use the potential financial assistance schemes introduced by the Government to meet the working capital needs and manage them efficiently to generate required revenue from their business.

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Original Article

IMPACT OF THERMAL RADIATION AND VISCOUS DISSIPATION ON MHD FLOW OF JEFFREY LIQUID OVER AN INFINITE VERTICAL CHANNEL

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ABSTRACT

In this investigation hydro magnetic progression of Jeffrey liquid over an unending vertical channel with thermal radiation and viscous dissipation is thought of. The governing non linear ordinary differential equations are disentangled by utilizing shooting framework. The impacts of governing parameters such as Jeffrey parameter, suction parameter, thermal grash of number, magnetic field parameter, radiation parameter and Eckert number on the liquid speed and the temperature are demonstrated graphically. The coefficient of skin friction and the local Nusselt number are resolved numerically and showed up in tabular structure. The current outcomes have been great concurrence with the previous results under some exceptional cases.

KEYWORDS: MHD, Jeffrey liquid, Shooting technique & Heat transfer

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NOMENCLATURE

u' is the velocity of the fluid in x' -direction	β is the volume coefficient of thermal expansion.
T' is the fluid temperature	B_0 is strength of the magnetic field along
h is the coefficient of heat transfer	y' - axis.
k is the thermal conductivity	λ_1 is the Jeffrey parameter
v' is the suction velocity	Gr is the thermal Grashof number
ν is the kinematic viscosity	M is the magnetic field parameter
T'_∞ is the free stream temperature	u, θ are the fluid flow velocity and the temperature respectively
g is the gravity of acceleration	Pr is the Prandtl number
σ is the electrical conductivity of the fluid	R is the radiation parameter,
ρ is density of the fluid	Ec is the Eckert number.
S is the suction parameter	μ is the viscosity
c_p is the specific heat constant	
q_r is the radiative heat flux along y' -axis	

1. INTRODUCTION

The non-Newtonian liquids wonders are utilized in numerous engineering and industrial areas. Jeffrey liquid could be one of the non-Newtonian liquid. It was changed to as Newtonian liquid by putting $\lambda_1 = 0$. Radiation impact has numerous applications in physics, engineering and industry including polymer processing, glass production,

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nuclear reactors and in space technology like power plants, rocket and missiles. Sunlight, moreover called sun based radiation could be a shape of radiation that began from the Sun. Venkateswara Raju *et al.* [1] studied an unsteady MHD free convection Jeffrey fluid flow radiating and reacting past a vertical porous plate in slip flow regime with heat source. Nor Athirah Mohd Zin *et al.* [2] developed the impact silver nanoparticles on MHD free convection flow of Jeffrey fluid over an oscillating vertical plate embedded in a porous medium. MHD oscillatory flow of a Jeffrey fluid in a vertical porous channel with viscous dissipation was developed by Selvi *et al.* [3]. Kartini Ahamd *et al.* [4] investigated MHD Jeffrey fluid over a stretching vertical surface in a porous medium. Peristaltic flow of a Bingham fluid in contact with a Jeffrey fluid was analyzed Saravana *et al.* [5]. Peristaltic transport of a Jeffrey fluid in contact with a Newtonian fluid in an inclined channel was reported by Kavitha *et al.* [6]. Krishna Murthy *et al.* [7-10] examined MHD three dimensional flow of Jeffrey fluid over an exponentially stretching sheet. Steady MHD three dimensional flow of Jeffrey fluid over an exponentially stretching sheet with slip conditions. Effects of heat and mass transfer flow of a Jeffrey fluid through a vertical deformable porous stratum and MHD Couette flow of Jeffrey fluid in a porous channel with heat source and chemical reaction. Sreenadh *et al.* [11, 12] analyzed MHD Couette flow of a Jeffrey fluid over a deformable porous layer and free convection flow of a Jeffrey fluid through a vertical deformable porous stratum. Eldabe *et al.* [13] reported peristaltic flow of MHD Jeffrey fluid through porous medium in a vertical channel with heat and mass transfer with radiation. Nor Athirah Mohd Zin *et al.* [14] developed exact and numerical solutions for unsteady heat and mass transfer problem of Jeffrey fluid with MHD and Newtonian heating effects. Mahesh Kumar *et al.* [15] founded transient entropy analysis of the magnetohydrodynamics flow of a Jeffrey fluid isothermal vertical flat plate.

Vijaya *et al.* [16] reported soret and radiation effects on an unsteady flow of a Casson fluid through porous vertical channel with expansion and contraction. Athira *et al.* [17] investigated non-linear convection in chemically reacting fluid with an induced magnetic field across a vertical porous plate in the presence of heat source/sink. Sarojamma *et al.* [18] analyzed non-linear radiative flow of a micropolar nanofluid through a vertical channel with porous collapsible walls. Marneni Narahari *et al.* [19,20] studied MHD natural convection flow past an impulsively started infinite vertical porous plate with Newtonian heating in the presence of radiation and effects of thermal radiation and mass diffusion on free convection flow near a vertical plate with Newtonian heating. Kavitha *et al.* [21] discussed peristaltic transport of a Jeffrey fluid in contact with Newtonian fluid in an inclined channel. Peristaltic pumping of a power-law fluid in contact with a Jeffrey fluid in an inclined channel with permeable walls was developed by Sreenadh *et al.* [22]. Selvi *et al.* [23] investigated the effect of heat transfer on peristaltic flow of Jeffrey fluid in an inclined porous stratum. Numerical study of a Jeffrey fluid over a porous stretching sheet with heat source/sink was reported by Venkata Ramana *et al.* [24] Muhammad Ijaz Khan *et al.* [25] studied effectiveness of radiative heat flux in MHD flow of Jeffrey-nanofluid subject to brownian and thermophoresis diffusions,

The show think about hydro magnetic flow of Jeffrey liquid over an infinite vertical channel with thermal radiation and viscous dissipation is inspected. The governing non linear differential equations are illuminated utilizing shooting strategy. The impacts of germane governing parameters on the liquid velocity and the temperature are appeared graphically. The coefficient of skin friction and the Nusselt numbers is calculated numerically and are appeared tabular structure. The present outcomes have been great assention with existing ponders beneath a few uncommon cases.

2. MATHEMATICAL FORMULATION OF THE PROBLEM

Consider steady hydro magnetic stream of Jeffrey liquid over an infinite vertical channel with thermal radiation and

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viscous dissipation. The x' - axis is taken as along the plate within the upward direction and y' - axis normal to it appeared in Figure 1. Assumed that the heat transfer rate from the plate with a finite heat capacity is corresponding to the local surface temperature (T'). The beneath Boussinesq estimation for the continuity equation, the momentum equation and the energy equations are as takes after:

$$\frac{\partial v'}{\partial y'} = 0 \tag{1}$$

$$v'\frac{\partial u'}{\partial y'} = \frac{\nu}{1+\lambda_1}\frac{\partial^2 u'}{\partial y'^2} + g\beta\left(T' - T_\infty'\right) - \frac{\sigma B_0^2}{\rho}u' \tag{2}$$

$$v'\frac{\partial T'}{\partial y'} = \frac{k}{\rho c_p}\frac{\partial^2 T'}{\partial y'^2} - \frac{1}{\rho c_p}\frac{\partial q_r}{\partial y'} + \frac{\mu}{\rho c_p\left(1+\lambda_1\right)}\left(\frac{\partial u'}{\partial y'}\right)^2 + \frac{\sigma B_0^2}{\rho}u'^2 \tag{3}$$

The limit conditions are as per the following:

$$\left.\begin{aligned} u' = u_0, \frac{\partial T'}{\partial y'} = -\frac{h}{k}T' \; at \; y' = 0 \\ u' \to 0, T' \to T_\infty' \; as \; y' \to \infty \end{aligned}\right\} \tag{4}$$

Integrating equation (1) for suction constant, we have

$$v' = -v_0 \tag{5}$$

where $v_0 > 0$ is the normal velocity of suction at the plate.

Now equation (2) and (3) are as per the following:

$$-v_0\frac{\partial u'}{\partial y'} = \frac{\nu}{1+\lambda_1}\frac{\partial^2 u'}{\partial y'^2} + g\beta\left(T' - T_\infty'\right) - \frac{\sigma B_0^2}{\rho}u' \tag{6}$$

$$-v_0\frac{\partial T'}{\partial y'} = \frac{k}{\rho c_p}\frac{\partial^2 T'}{\partial y'^2} - \frac{1}{\rho c_p}\frac{\partial q_r}{\partial y'} + \frac{\mu}{\rho c_p\left(1+\lambda_1\right)}\left(\frac{\partial u'}{\partial y'}\right)^2 + \frac{\sigma B_0^2}{\rho}u'^2 \tag{7}$$

The radiation heat flux q_r in equation (7) fulfills the accompanying non-linear differential equation (Narahari *et al.* [20])

$$\frac{\partial q_r}{\partial y'} = 4a\sigma^*\left(T'^4 - T_\infty'^4\right) \tag{8}$$

where a is the absorption coefficient and σ^* is the Stefan-Boltzman constant. Assuming that the temperature differences inside the steam are adequately little such that T'^4 can be expressed as a linear function of T' and utilizing the Taylor series articulation about T'^4 in the wake of disregarding higher order terms, we have:

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$$T'^4 \cong 4T_\infty'^3 T' - 3T_\infty'^4 \tag{9}$$

From equations (8), (9) and (7) we get

$$-v_0 \frac{\partial T'}{\partial y'} = \frac{k}{\rho c_p}\frac{\partial^2 T'}{\partial y'^2} - \frac{16\alpha\sigma^* T_\infty'^3}{\rho c_p}(T' - T_\infty') + \frac{\mu}{\rho c_p (1+\lambda_1)}\left(\frac{\partial u'}{\partial y'}\right)^2 + \frac{\sigma B_0^2}{\rho} u'^2 \tag{10}$$

The non-dimensional quantities are as per the following:

$$\left.\begin{aligned} y = \frac{y'h}{k}, u = \frac{u'}{u_0}, \theta = \frac{T' - T_\infty'}{T_\infty'}, S = \frac{v_0 k}{h\nu}, M = \frac{\sigma B_0^2 k^2}{\mu h^2} \\ Gr = \frac{g\beta T_\infty' k^2}{\nu u_0 h^2}, \Pr = \frac{\mu c_p}{k}, Ec = \frac{\mu u_0^2}{k T_\infty'}, R = \frac{16\alpha\sigma^* k T_\infty'^3}{h^2} \end{aligned}\right\} \tag{11}$$

Utilizing equation (11), from equations (6), (10) and (4) are as per the following:

$$\frac{1}{1+\lambda_1}\frac{d^2u}{dy^2} + S\frac{du}{dy} + Gr\theta - Mu = 0 \tag{12}$$

$$\frac{d^2\theta}{dy^2} + \Pr S\frac{d\theta}{dy} - R\theta + \frac{Ec}{1+\lambda_1}\left(\frac{du}{dy}\right)^2 + EcMu^2 = 0 \tag{13}$$

The limit conditions are

$$\left.\begin{aligned} u = 1, \frac{d\theta}{dy} = -(\theta+1)\, at\ y = 0 \\ u \to 0, \theta \to 0\, as\ y \to \infty \end{aligned}\right\} \tag{14}$$

Physical amounts of intrigue are the coefficient of skin friction C_f and the local Nusselt number Nu are characterized as

$$C_f = \frac{\tau'}{\rho G r u_0^2} = -\frac{1}{1+\lambda_1}\left.\frac{du}{dy}\right|_{y=0} \text{ and } Nu = -\frac{\nu}{u_0(T' - T_\infty')}\left.\frac{dT'}{dy'}\right|_{y=0} = 1 + \frac{1}{\theta(0)} \tag{15}$$

3. RESULTS AND DISCUSSIONS

The current investigation uncovers that the hydro magnetic flow of Jeffrey fluid over an limitless vertical channel with thermal radiation and viscous dissipation. In this paper we stood out the diagrams from Newtonian liquid $(\lambda_1 = 0)$ and non-Newtonian liquid (i.e. Jeffrey liquid $(\lambda_1 \neq 0)$). The non-linear governing equations are comprehended by utilizing shooting strategy. The impacts of governing parameters on the liquid velocity and the temperature are exhibited with the assistance of the graphs. The coefficient of the skin friction and the local Nusselt number are assessed numerically and appeared in tabular structure. The present outcomes have been great concurrence with the existing investigations Narahari

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et al. [19] under some constraining cases.

The impact of magnetic field parameter M on the liquid velocity $u(y)$ and the temperature $\theta(y)$ are shown in Figures 2 and 3. We watched that the velocity diminished with expanding magnetic field parameter and the inverse behavior in temperature conveyance. This causes the Lorentz force impact. The variety on the liquid velocity $u(y)$ and the temperature $\theta(y)$ with the impact of Jeffrey parameter λ_1 are illustrated in Figures 4 and 5. We have seen that the liquid velocity and the temperature are rot for higher values of Jeffrey parameter. From Figures 6 and 7 outlines the impact of suction parameter S on the liquid velocity $u(y)$ and the temperature $\theta(y)$. We taken note that the liquid velocity and the temperature are diminish with improve suction parameter. In reality that of the impact of the suction is to take away the hot fluid on the vertical plate and subsequently diminishing the liquid velocity and the temperature with diminishes free convection streams concentrated. The impact of thermal Grashof number Gr on the liquid velocity $u(y)$ is appeared in Figure 8. We uncover that the liquid velocity improves with upgrading thermal Grashof number. This causes the higher values of thermal Grashof number at the point the viscous force impact rots and increments in momentum boundary layer thickness. The variety on temperature distribution $\theta(y)$ with the impact of radiation parameter R is spoken to in Figure 9. We look at that the temperature diminishes for improving radiation parameter. This reality that for higher values of thermal radiation parameter have inclination to assimilate the radiative heat and in this way the buoyancy force rots as well as thermal boundary layer diminishes. The impact of Eckert number Ec on the temperature distribution $\theta(y)$ is shown in Figure 10. We have taken note that the temperature increments with expanding Eckert number. This causes energy created by work done inverse the viscous liquid stresses.

The coefficient skin friction and the local Nusselt number numerical qualities for various governing parameters are introduced in Table 1. We have seen that the coefficient skin friction increments with expanding Prandtl number, magnetic field parameter, suction parameter and radiation parameter and the skin friction coefficient rots for higher estimations of Grashof number and Eckert number. The Nusselt number improves for upgrading Prandtl number, Grashof number, radiation parameter and suction parameter and the Nusselt number declines for higher estimations of Eckert number and magnetic field parameter. The present outcomes have been great concurrence with the current outcomes Narahari *et al.* [19] when the non appearance of Jeffrey parameter $(\lambda_1 = 0)$.

4. CONCLUSIONS

In this paper we study the hydrodynamic flow of Jeffrey liquid over an infinite vertical channel with viscous dissipation and thermal radiation. The non linear differential equations are illuminated utilizing shooting system. The impacts of magnetic parameter, Jeffrey parameter, suction parameter, radiation parameter, Grashof number, Eckert number on the liquid velocity and the temperature are appeared in graphically. The coefficient of skin friction and the local Nusselt number are determined numerically and are shown in tabular structure. The targets of the present paper are as per the following:

- The momentum boundary layer thickness diminishes for higher estimations of magnetic parameter while we

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watched the contrary nature in thermal boundary layer thickness.

- The liquid velocity and the temperature are rots with the impact of Jeffrey parameter and the suction parameter.
- The impact of Grashof number the velocity upgrades and the impact of radiation parameter the temperature diminishes. The temperature increments for higher estimations of Eckert number.
- The coefficient skin friction increments with expanding Prandtl number, magnetic field parameter, suction parameter and radiation parameter and the skin friction coefficient rots for higher estimations of Grashof number and Eckert number. The Nusselt number upgrades for improving Prandtl number, Grashof number, radiation parameter and suction parameter and the Nusselt number reductions for higher estimations of Eckert number and magnetic field parameter.

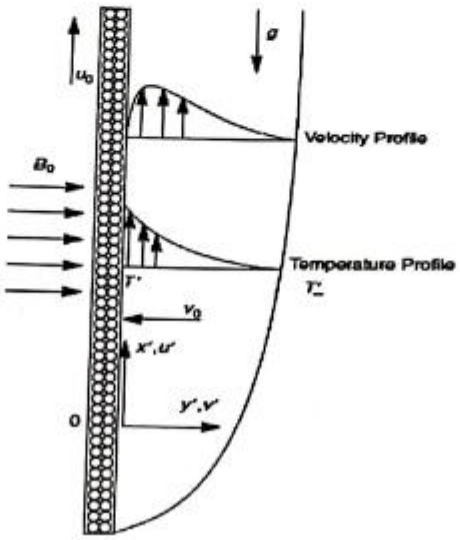

Figure 1: The Physical Model of the Problem

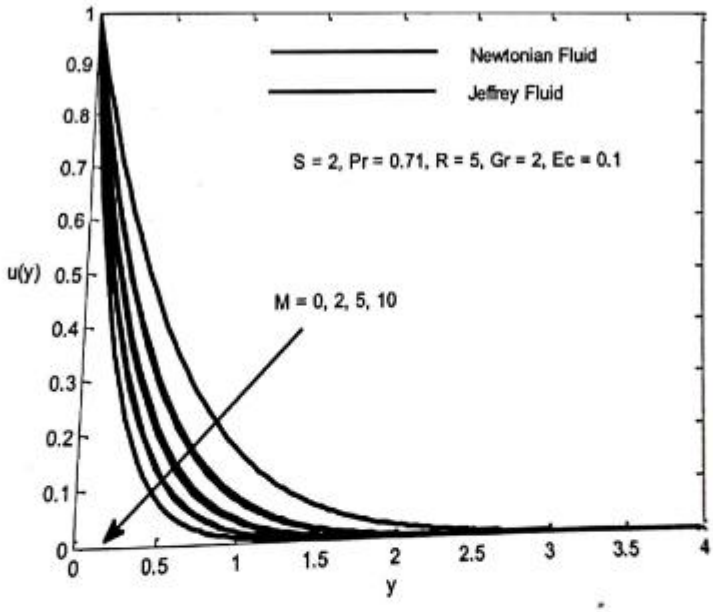

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Figure 2: The Impact of M on the Fluid Velocity $u(y)$

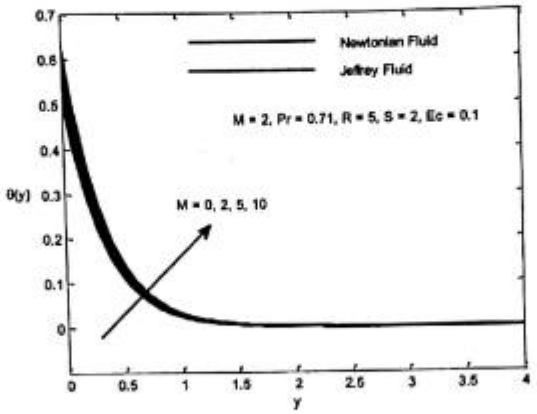

Figure 3: The Impact of M on the Temperature Distribution $\theta(y)$

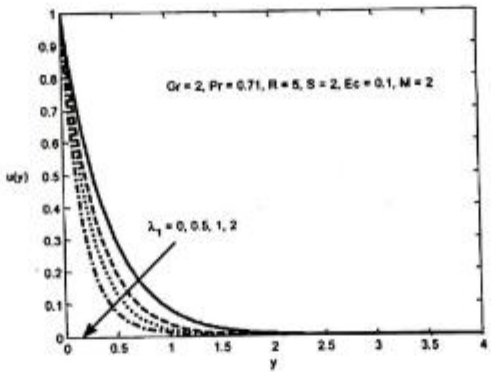

Figure 4: The Impact of λ_1 on the Fluid Velocity $u(y)$

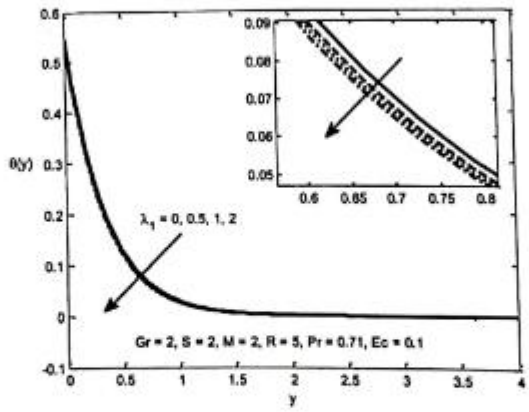

Figure 5: The Impact of λ_1 on the Temperature Distribution $\theta(y)$

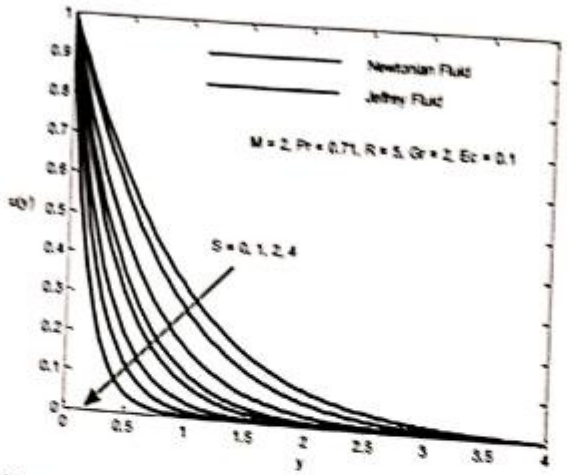

Figure 6: The Impact of S on the Fluid Velocity $u(y)$

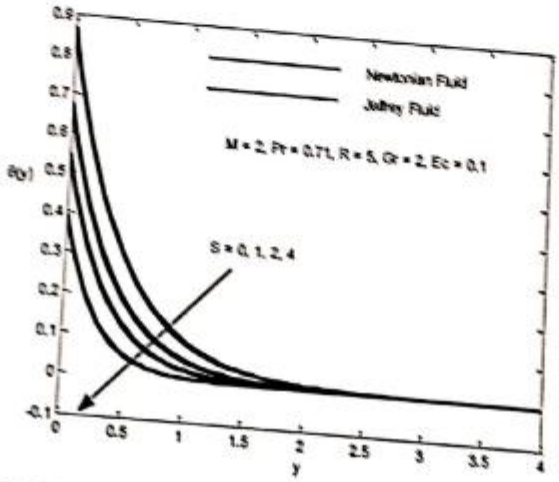

Figure 7: The Impact of S on the Temperature Distribution $\theta(y)$

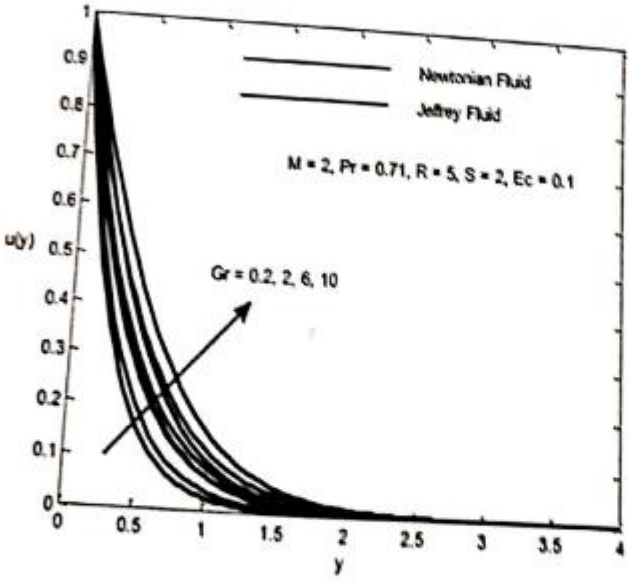

Figure 8: The Impact of Gr on the Fluid Velocity $u(y)$

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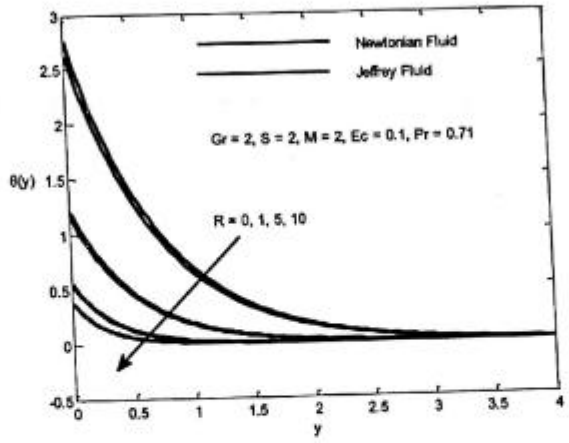

Figure 9: The Impact of R on the Temperature Distribution $\theta(y)$

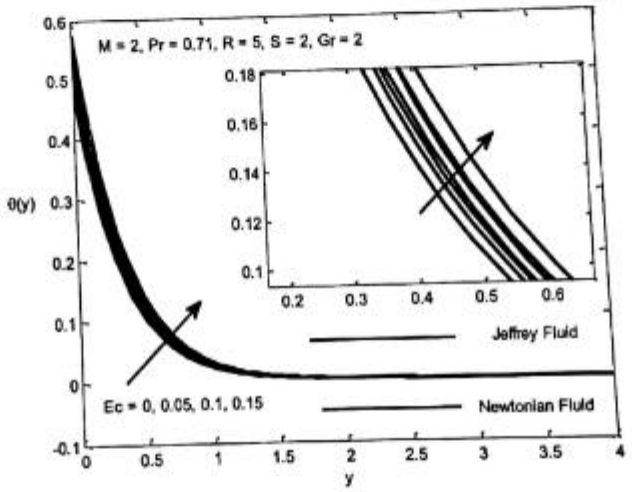

Figure 10: The Impact of Ec on the Temperature Distribution $\theta(y)$

Table 1: The Numerical Values of the coefficient of Skin Friction Number Cf and the Local Nusselt number Nu for different values of $\Pr, Gr, Ec, S, M$ and R when the absence of Jeffrey parameter $(\lambda_1 = 0)$.

Pr	Gr	Ec	S	M	R	Cf		Nu	
						Naraharl *et al.*[19]	Present result $(\lambda_1 = 0)$	Naraharl *et al.*[19]	Present result $(\lambda_1 = 0)$
0.3	2	0.1	2	2	5	2.187823	2.1878231	2.408550	2.4085501
0.71						2.318805	2.3188052	2.843596	2.8435963
1						2.380207	2.3802073	3.184474	3.1844745
3						2.432189	2.4321890	6.043606	6.0436067
7						2.445486	2.4454862	12.70957	12.709579
0.71	0.2					2.616490	2.6164901	2.825782	2.8257823
	6					1.803467	1.8034673	2.863637	2.8636372
	10					1.246268	1.2462685	2.880430	2.8804304

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	15 2	0 0.05 0.1 0.15 0.2 0.1	0 1 4 6 2	0 5 10 2	0 1 5 10 20	0.539239 2.399372 2.380807 2.362325 2.343924 2.325601 0.938857 1.588374 3.918558 5.602275 1.635060 2.998375 3.439559 0.997461 1.747897 2.052392 2.148354 2.215011	0.5392397 2.3993729 2.3808072 2.3623254 2.3439246 2.3256018 0.9388570 1.5883741 3.9185583 5.6022755 1.6350607 2.9983759 3.4395592 0.9974614 1.7478976 2.0523928 2.1483540 2.2150113	2.889943 3.055982 2.941027 2.839202 2.748379 2.666867 2.153464 2.486149 3.591152 4.331709 2.940836 2.748319 2.665627 1.434802 1.835384 2.859875 3.693427 4.904925	2.8899436 3.0559828 2.9410270 2.8392021 2.7483793 2.6668675 2.1534647 2.4861499 3.5911520 4.3317092 2.9408364 2.7483196 2.6656278 1.4348029 1.8353846 2.8598752 3.6934274 4.9049256

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METHODS AND APPLICATIONS OF LINEAR REGRESSION MODELS

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ABSTRACT:
Linear regression analysis is a statistical phenomenon in order to evaluate the association between the variables. Multiple linear regression models are the one in which there is one dependent variable and more than one independent variables. Regression analysis is an important tool to identify and characterize the relationshipsof multiple factors. The goal of this article is to introduce some methods and applications of linear regression models. The central concepts in linear regression analysis namely estimation theory, maximum likelihood, and linear hypothesis are comprehensively discussed. Moreover an innovative proof of Gauss –Markov theorem in full rank case has been proposed here.

Keywords: Linear Regression, Estimation Theory, Maximum Likelihood, Linear Hypothesis, Testing of hypothesis,

Introduction:

In 1894, Sir Francis Galton introduced the concept of linear regression. Linear regression analysis is a statistical tool applied to the given set of data. In order to trace the quantifying relationship between variables. In 2018, khushbukumari et al. , in their article explained the fundamental properties of linear regression and the methods of performing its calculations in SPSS and excel. Gulden kaya Uyanik et al. in 2013, in their paper,examined the assumptions of multi linear regression analysis –normality,linearity, no extreme values and missing value analysis. RoddyTheobold, in 2017, in their research paper,described an effective frame work of multiple linear regression models. FatemahJalayer et al, in 2015, in their research article,explained Bayesian cloud analysis using linear regression. Gibbs Y. Kanyongo, in 2006, in their research article,applied linear regression analysis in framing the association between home and reading environments.

The specific form of linear hypothesis is described by

$$\bar{z} = \alpha_1 \bar{y}_1 + ... + \alpha_l \bar{y}_l + \bar{\varepsilon} \qquad (1)$$

Here $\bar{y}_1, ... \bar{y}_l$ are given vectors of constants

$\bar{\varepsilon}$ follows $N_m(\bar{0}, \sigma^2 I_m)$

The unknown parameters are $\alpha_1 .... \alpha_l$.

(1) is also known as multiple regression model.

This model includes a large number regression models namely analysis of covariance, one-way analysis of variance , two –way analysis of variance, higher order analysis of variance, simple linear regression. $\bar{z}, y_1, ... y_l$ usually take their values on the inner product space R_m. An $m \times l$ matrix $\bar{y} = (\bar{y}_1, ... \bar{y}_l)$ and the column vector $\bar{\alpha} = (\alpha_1, ... \alpha_l)^T$ change (1) as $\bar{z} = \bar{y}\bar{\alpha} + \bar{\varepsilon}$.

For instance

i) For the ordered pairs (y_j, z_j); j=1,2,…m
If we assume $z_j = \alpha y_j + \varepsilon_j$ then it takes
the vector form $\bar{z} = \alpha \bar{y} + \bar{\varepsilon}$ and it is known as regression through origin. If $\bar{y}$ is vector of all ones and α as μ then z_i follows normal distribution with mean μ and variance σ^2.

ii) Let z_{jk}= yield of wheat under condition i on j^{th} plot
y_{jk}= Fertility of plot k for condition j
k=1,….m_j , j=1,2

$$\psi = \text{Set of vectors} \begin{bmatrix} z_{11} & z_{21} \\ . & \\ . & \\ z_{1m_1} & z_{2m_2} \end{bmatrix}$$

$\bar{z} \in \psi$
$\bar{y}$ = corresponding vector of y_{jk}'s
Indicator of first column= $\bar{u}_1$

Indicator of second column= $\bar{u}_2$

Then the model $\bar{z} = \alpha_1 \bar{u}_1 + \alpha_2 \bar{u}_2 + \alpha_3 \bar{y} + \bar{\varepsilon}$ is to used.

iii) If the pairs $(y_j, z_j), j = 1,2...m$ are observed then the model is
$\bar{z}_j = \alpha_0 + \alpha_1 y_j + \alpha_2 y_j^{\,2} + \alpha_3 y_j^{\,3} + \varepsilon_j$

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$\varepsilon_1, \varepsilon_2, \ldots \varepsilon_n$ are independent with the distribution $N(0,\sigma^2)$

Renaming 1 by u_{oj},,y_j by u_{1j}, y^2_j by u_{2j} and y^3_j by u_{3j} the above becomes

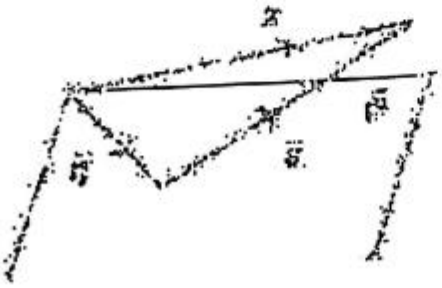
$$z_i = \sum_{k=0}^{3} \alpha_k u_{kj}$$

In vectors it is denoted by $\bar{z} = \sum_{k=0}^{3} \alpha_k u_k + \varepsilon$

2. Estimation Theory:

The linear hypothesis can be put as

$\bar{z} = \bar{\eta} + \bar{\varepsilon}$ and described by the following Fig.



$\bar{\eta} \in \bar{V} = L(y_1, \ldots y_l)$
$\bar{\varepsilon} \sim N(\bar{0}, \sigma^2 I_n)$

In some cases it sufficesto compute $\bar{\eta}$ and its representation as $\sum_{k=1}^{l} \alpha_k y_k$ is not that much important. But the regression coefficients $\alpha_1, \ldots \alpha_l$ have much importance. Hence matrix notation is implemented. Each and every vector is treated as a column. Put $\bar{y} = (y_1, \ldots y_l)$ and call by design matrix. Now $\eta = \bar{y}\alpha$. If $y_1, \ldots y_l$ are LI then one can have

$(\bar{y}^T \bar{y})^{-1} \bar{y}^T \bar{n} = \alpha$

The least squares phenomenon estimates η and let

It be $\hat{\eta}$ which minimizes $\|\bar{z} - \eta\|^2 = W(\eta)$

Here $\eta \in \bar{V}$ and $\hat{\eta} = P\left(\bar{z}/\bar{v}\right) = \bar{z}$

If $\bar{y}$ has full column rank then

$\hat{\eta} = \bar{y}(\bar{y}^T \bar{y})^{-1} \bar{y}^T \bar{z}$

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$$\hat{\alpha} = (\bar{y}^T \bar{y})^{-1} \bar{y}^T \bar{z}$$

Consequently $\hat{\alpha} = (\bar{y}^T \bar{y})^{-1} \bar{y}^T (\bar{y}\beta + \varepsilon)$

$$= \bar{\beta} + (\bar{y}^T \bar{y})^{-1} \bar{y}^T \varepsilon$$

Here $(\bar{y}^T \bar{y})^{-1} \bar{y}^T$ is the Moore-Penrose inverse $\bar{y}^+$ of $\bar{y}$ and it is called the coefficient matrix.

If the column vector of $\bar{y}$ are orthogonal then

$$\bar{z} = \sum p\left(\bar{z}/y_k\right) = \sum \hat{\alpha}_k y_k$$

Where $\hat{\alpha}_k = (\bar{z}, y_k)/\|y_k\|^2$

$$= \alpha_k + (\varepsilon, y_k)/\|y_k\|^2$$

Moreover $E(\hat{\bar{\alpha}}) = \bar{\alpha} + (\bar{y}^T \bar{y})^{-1} \bar{y}^T E(\varepsilon) = \bar{\alpha}$

$$D(\hat{\bar{\alpha}}) = D\left[(\bar{y}^T \bar{y})^{-1} \bar{y}^T \varepsilon\right]$$

$$= (\bar{y}^T \bar{y})^{-1} \bar{y}^T (\sigma^2 I_m)\left[(\bar{y}^T \bar{y})\bar{y}^T\right]^T$$

$$= (\bar{y}^T \bar{y})^{-1} \sigma^2$$

$\hat{\bar{\alpha}}$ Follows a multivariate normal distribution.

3. Maximum Likelihood:

The likelihood function is

$$L(\eta, \sigma^2, z) = (2\pi)^{\frac{m}{2}} \sigma^{-m} e^{-0.5\|z-\eta\|^2 \sigma^{-2}}$$

For each observed $\bar{z} = z$ and $\eta \in \bar{V} = L(y_1, \ldots . y_l)$

σ^2 is always +ve.

The phenomenon of maximum likelihood gives the estimates of the pair (η, σ^2) which optimises L for each $\bar{z} = z$. In other words it optimizes

$$\log L = -m(0.5)\log 2\pi - m(0.5)2\log\sigma - (0.5)\|z-\hat{\eta}\|^2 \sigma^{-2}$$

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By choosing $\eta = P\left(\eta/V\right) = \hat{\eta}$, log L is optimized for each fixed σ^2.

Moreover for this choice of η one can see

$$\log L = -m(0.5)\log 2\pi - m(0.5)2\log\sigma - (0.5)\|z-\hat{\eta}\|^2\sigma^{-2}$$

Replacing σ^2 by u and choosing the differential coefficients of u, one can obtain

$$\frac{d}{du}(\log L) = -m(0.5)u^{-1} + (0.5)\|z-\hat{\eta}\|^2 u^{-2}$$

This becomes 0 for $u = \hat{\sigma}^2 = \|z-\hat{\eta}\|^2 m^{-1}$

It can be easily seen that second derivative is –ve.

Hence $\hat{\sigma}^2 = \|z-\eta\|^2 m^{-1}$ optimizes log Lfor each $\hat{\eta}$. Consequently the pair $(\hat{\eta},\hat{\sigma}^2)$optimizes L .This pair is the MLE of (η,σ^2).

4. Estimation of σ^2

MLE of σ^2 **is** $\hat{\sigma}^2 = \|\bar{z}-\hat{\eta}\|^2 m^{-1}$

$$E(\hat{\sigma}^2) = \sigma^2 m^{-1}\dim(V^{\perp})$$
$$= \sigma^2 m^{-1}(m-\dim V)$$

$\hat{\sigma}^2$ is a biased estimates of σ^2

Hence the commonly used estimates of σ^2 **is**

$$R^2 = \|\bar{z}-\hat{\eta}\|^2[m-\dim V]^{-1}$$

If ε has a MND then $\|\bar{z}-\hat{\eta}\|^2\sigma^{-2} \sim \chi^2_{m-\dim V}$.

As the central χ^2 distribution with n degrees of freedom has a variance 2n, one can obtain

$$Var(R^2) = 2\sigma^4[m-\dim V][m-\dim V]^{-2}$$
$$= 2\sigma^4[m-\dim V]^{-1}$$

5. Properties of $\hat{\eta}$ and R^2

By facts that $\hat{\eta} = P\left(\bar{z}/V\right), \bar{z}-\hat{\eta} = P(\bar{z}|V^{\perp})$

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V and $V^{\perp}$ are orthogonal spaces, one can see that $\hat{\eta}$ and $\bar{z}-\hat{\eta}$ are uncorrelated random vectors, which are independent under normality.

Hence $\hat{\eta}$ and $R^2 = \|\bar{z}-\hat{\eta}\|^2[m-\dim V]^{-1}$ are independent in the case that the columns of $\bar{y}$ are a basis for V.

If $\bar{z}$ is a multivariate normal random variable $\hat{\alpha} = (\bar{y}^T\bar{y})^{-1}\bar{y}^T\hat{\eta} = (\bar{y}^T\bar{y})^{-1}\bar{y}^T\bar{z}$ and the residual vector $\bar{e} = \bar{z}-\hat{\eta}$ are uncorrelated independent random vectors.

In order to summerize all the results under the model $\bar{z} = \hat{\eta} + \hat{\varepsilon}$ for $\hat{\eta} \in V$, $\varepsilon \sim N_m(\bar{0}, \sigma^2 I_m)$

One can obtain the following

i) $\hat{\eta} \sim N_m(\eta, P_v\sigma^2)$

ii) $e = \bar{z}-\hat{\eta} \sim N_m(\bar{0}, (I_m - P_V)\sigma^2)$

iii) $\hat{\eta}$ and $\bar{z}-\hat{\eta}$ are independent random vectors

iv) $\|\bar{z}-\hat{\eta}\|^2\sigma^2 \sim \chi^2_{m-\dim V}$

v) Hence $R^2 = \|\bar{z}-\hat{\eta}\|^2(m-\dim V)^{-1}$ is an unbiased estimator of σ^2

vi) If the columns of $\bar{y}$ serve as a basis of V and $\bar{\eta} = \bar{y}\bar{\alpha}$ then $\bar{\alpha} = (\bar{y}^T\bar{y})^{-1}\bar{y}^T\bar{z}$ and R^2 are independent provided $\hat{\bar{\alpha}} = N_l(\bar{\alpha}, ((\bar{y}^T\bar{y})^{-1})\sigma^2)$.Besides the columns of $\bar{y}$ are mutual orthogonal the estimators $\hat{\alpha}$ are not correlated and hence they become independent.

6. Confidence intervals and Tests on $\theta = a_1\alpha_1 + \ldots\ldots + a_l\alpha_l$

One is generally interested in a linear combination $\theta = (\bar{a}, \bar{\alpha}) = a_1\alpha_1 + \ldots\ldots + a_l\alpha_l$. $\hat{\theta}$ is an unbiased estimator of θ by the linearity of expectation. Its variance is given by

$$Var(\hat{\theta}) = \bar{a}^1\bar{N}^{-1}\bar{a}\sigma^2$$
$$= d\sigma^2$$

Here $\bar{N}$ is the inner product matrix.

The corresponding estimator of $Var(\hat{\theta})$ is $S_\theta{}^2 = dS^2$

Particularly when $\theta = \alpha_k$, a is the k^{th} unit vector and d is the kk term of N^{-1}.

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$$\hat{\theta} \sim N(\theta, d\sigma^2)$$

Hence $\dfrac{\hat{\theta}-\theta}{\sqrt{d\sigma^2}} \sim N(0,1)$

$$\frac{\hat{\theta}-\theta}{\sqrt{dS^2}} \sim t_{m-2}$$

Therefore for $t = t_{m-l,1-\alpha}$, $1-\alpha = P\left(-t \le \dfrac{\hat{\theta}-\theta}{\sqrt{dS^2}} \sim t\right)$

$$P\left(\hat{\theta}\right) - t\sqrt{ds^2} \le \theta \le \hat{\theta} + t\sqrt{ds^2}$$

Hence $\left[\hat{\theta} + t_{m-l,1-\alpha}\sqrt{ds^2}\right]$ is a $100(1-\alpha)\%$ confidence interval on θ.

7. Tests of hypothesis on $\theta = \sum a_k \alpha_k$

Let one want to test $H_0 : \theta \le \theta_0$ versus $H_1 : \theta > \theta_0$

Here θ_0 is a known constant, generally it is 0.

Since $t = \dfrac{\hat{\theta}-\theta_0}{\sqrt{dS^2}} \sim t_{m-l}\left(\dfrac{\hat{\theta}-\theta_0}{\sqrt{d\sigma^2}}\right)$

And this becomes central t where $\theta = \theta_0$.

The tests which reject Ho for $t = \dfrac{\hat{\theta}-\theta_0}{\sqrt{S^2 d}} > t_{m-l,1-\alpha}$ is an α - level test. The two sided hypothesis

$H_0 : \theta = \theta_0$ versus $H_1 : \theta \ne \theta_0$ is rejected for $|t| \ge t_{m-l,1-\alpha(0.5)}$

8. The Gauss-Markov theorem :(Full rank case)

Suppose $\bar{z} = \sum_{k=1}^{l} \beta_k y_k + \varepsilon$ where $y_1 \ldots y_l$ are L.I.

here $E(\varepsilon) = 0$, $D(\varepsilon) = \sigma^2 I_n$.

Let $\theta = \sum a_k \alpha_k$ and θ^* be any linear unbiased estimator of θ.

Then $Var(\theta^*) \ge Var(\hat{\theta})$ with equality only if $\theta^* = \hat{\theta}\ \forall\ \bar{V}$

Proof: $\alpha = \left(\bar{y}^T \bar{y}\right)^{-1} \bar{y}^T \eta$ and $\theta = \bar{a}^T \bar{\alpha} = \bar{a}^T \left(\bar{y}^T \bar{y}\right)^{-1} \bar{y}^T \eta = \left(\bar{b}, \eta\right)$

Where $\bar{b} = \bar{y}\left(\bar{y}^T \bar{y}\right)^{-1} \bar{a}$.

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Take any linear estimator $\theta^* = (\bar{d}, \bar{z})$ of θ. Then

$E(\theta^*) = (\bar{d}, \bar{\eta})$

θ^* is unbiased for θ if $(\bar{d}, \bar{\eta}) = (\bar{b}, \bar{\eta}) \forall \eta \in \bar{V}$

That is if $(\bar{d} - \bar{b}, \bar{\eta}) = 0$ for all $\eta \in \bar{V}$

In other wordsif $(\bar{d} - \bar{b}) \perp V$ then

$$\theta^* = (\bar{d}, \bar{z}) = (\bar{b}, \bar{z}) + (\bar{d} - \bar{b}, \bar{z}) = \hat{\theta} + (\bar{d} - \bar{b}, \eta + \varepsilon)$$
$$= \hat{\theta} + (\bar{d} - \bar{b}, \varepsilon)$$

As $\bar{b} \perp (\bar{d} - \bar{b})$, the random variables $\hat{\theta}$ and $(\bar{d} - \bar{b}, \bar{a})$ are uncorrelated. Hence one can see

$Var(\theta^*) = Var(\hat{\theta}) + \|\bar{d} - \bar{b}\|^2 \sigma^2$

Consequently $Var(\theta^*) \geq Var(\hat{\theta})$ withequality only if $\bar{d} = \bar{b}$ i.e $\theta^* = \hat{\theta}$ for all V.

9. Conclusions and Future Research:

The above talk mainly explores on most important concepts of linear regression analysis namely estimation theory, maximum likelihood, specific form of linear hypothesis ,testing of hypothesis and an innovative proof of Gauss-Markov theorem for full rank case. In the context of future research one can extend these ideas to Gauss-Markov theorem for the general case, interpretation of regression coefficients, multiple correlation coefficient and partial correlation coefficient.

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AN ANALYSIS OF TRENDS IN VENTURE CAPITAL FUNDS IN INDIA AND THE IMPACT OF COVID 19

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ABSTRACT

It is a proved fact that entrepreneurship facilitates the creation of innovative enterprises, which in turn influences the improvement in competitiveness of the economy, particularly in India, where Start Ups are playing an important role in the development of innovative entrepreneurship. Venture Capital plays a significant role by providing risk capital and handholds the development of enterprises, thereby bridges the gap where traditional sources of funds cannot participate actively in funding new ventures, brings in smart advice, hand-on management support and other skills that help the entrepreneurial vision to be converted to marketable products. It was these inputs that made India to open its doors to private venture capital and the Venture Capital has made a significant contribution to development of entrepreneurship as well as improving competitiveness. The present paper primarily deals with the role of venture capital in the development of entrepreneurship in general and Start Ups in particular. Exclusively relying on secondary sources of data collected from international and national level reports prepared by reputed corporate institutes, research papers and reports of the Ministry of MSMEs, Government of India, this paper makes a modest attempt to analyze the role of Venture Capital in India. The analysis in this paper is focused on different aspects of venture capital investments in India. Special mention was made to the role of venture capital towards the contribution of capital and broad types of venture capital as an introduction to the present analysis. In the light of this introduction, a critical analysis is presented on introduction of venture capital in India, financing the investments to entrepreneurs, trends in venture capital investments in India during 2010-17, and to the recent trends influenced by COVID 19 with reference to the deals and their values, sector-wise venture capital attracted in India. A comparative analysis is provided highlighting the impact of COVID 19 for the period of January 2019 to June 2020. An attempt is also made to analyze the significance of the role of venture capital in generation of income and employment, as a financial mechanism for achieving the sustainable development and economic growth in India, the paper focuses the need for modifying the venture capital funds to play an active role for the industrial development in India, particularly for start-up enterprises.

KEYWORDS

COVID 19, venture capital investments, start ups, deals and investments.

JEL CODES

G10, G11, G19.

INTRODUCTION

During the post-financial crisis period, a new financing eco-system for new ventures has emerged particularly in recent years which have exerted significant implications both for investors and entrepreneurs. A variety of discussions took place and debates were made on the role of alternative funding channels. As a complementary effort there was a heavy pressure from seed and later stage Companies for alternative source of financing have arrived at a conclusion that the traditional closed-end venture capital funds be made as an unique investment process. However, investors have to be cautious for identifying successful investments and the identification must depend on skills and capabilities of the investors. A special focus was laid on financing entrepreneurial companies, especially start-ups and early stage ventures as start-up scene around the world was exploding and disrupting the existing business models. It was observed that investing in entrepreneurial ventures was characterized by very high degree of uncertainty and venture capitalists can create value despite high degree of uncertainty. Much attention was laid on understanding the venture capitalists own incentives and constraints which were found linked to the fund-raising cycle and the way in which the venture capital funds were structured. Being influenced by these experiences, entrepreneurial finance was explored by the following three perspectives:

1) The founder's perspective
2) The venture capitalists perspective, and
3) The investors backing the venture capital.

As a result of these explorations of perspectives, venture capital has emerged as an important source of funding, which had a significant effect on reshaping the start up ecosystem. Then onwards, the corporate entities have used a common approach to identify the funding options based upon the positioning of the company in its life cycle and decomposition of capital market industry into different segments, which were suitable for their maturity stage of development, size, typical investment needs, and availability of information on corporate ownership and governance models.

Attempts were made to identify the potential funding gaps, which was to be filled through appropriate funding strategies aimed at funding the most suitable type of financial investor. It was also identical that each financial system would be affected by a certain amount of allocative efficiency resulting in a gap, referred as the "primary funding gap" between the demand for financial resources for start-up companies and the supply of early stage equity capital, particularly for young and newly created small and medium sized enterprises. Consequent to this development thinking, the domain of venture capital was identified as the only source of external financing after the choices available for internal financing referred as "insider seed money". Consequently, venture capital has emerged as one of the major alternatives over the last two decades in the form of "information venture capital market"- such as "Business angels" and "Business Angel Organization".

OBJECTIVES

A critical examination of the performance of venture capital is the primary aim of the present paper, particularly in case of start ups in India. Besides this primary objective, the present paper aims at the following supplementary objectives also:

1. To assess the contribution of venture capital and financing the start ups in India
2. To analyse the trends in private equity /venture capital in India with reference to pre and post –COVID -19 periods (before 2019 and during 2019 and 2020.)
3. To present the recent trends in venture capital in India, and
4. To examine the reasons for slow growth of venture capital funds in India, and
5. To explain the implications of COVID-19 for venture capital funds in India.

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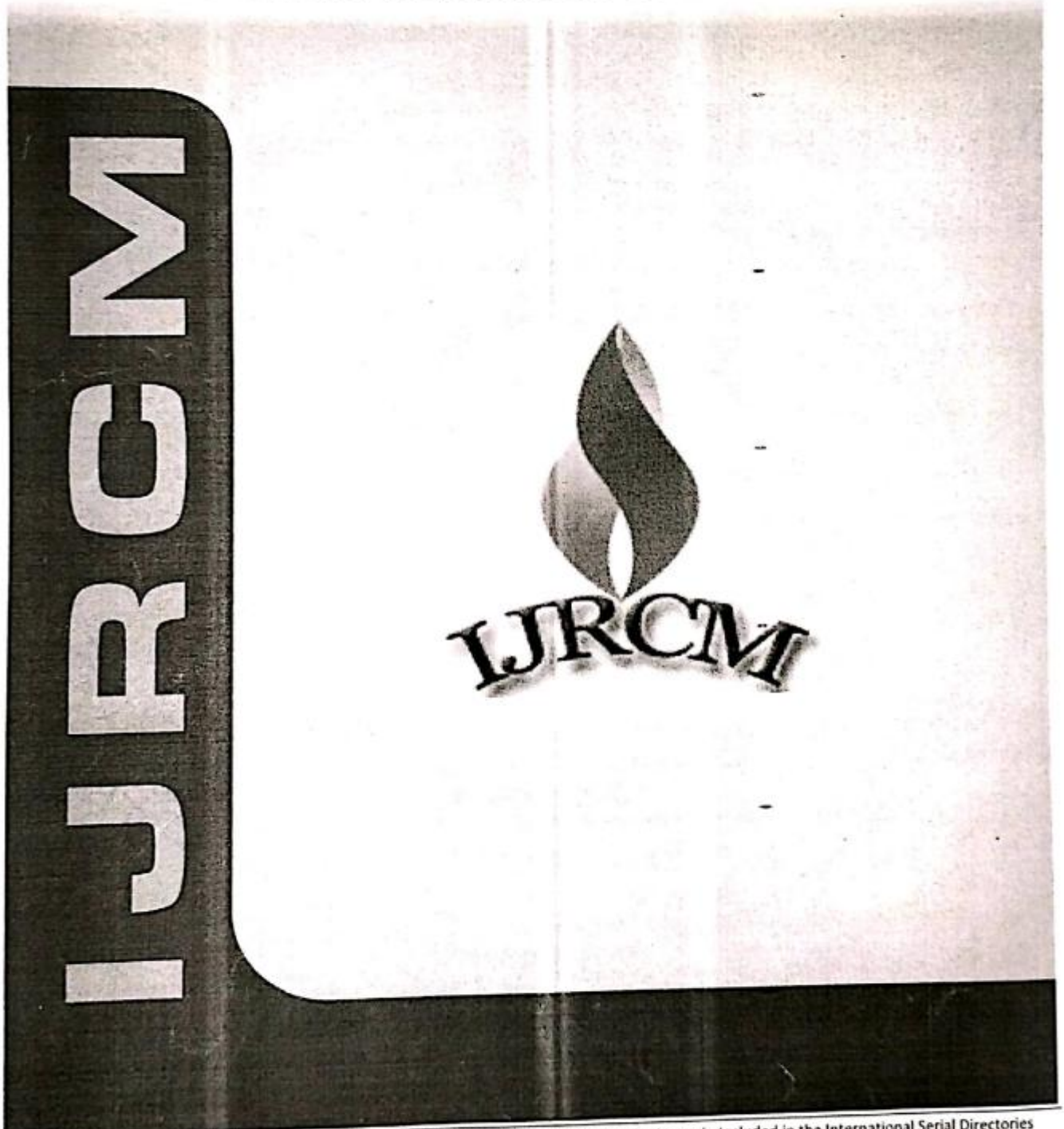

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TABLE 6: VENTURE CAPITAL INVESTMENTS BY TOP SECTORS (In $ MILLION)

S. No	Top sectors	First Half of 2019	Second Half of 2019	First Half of 2020*
1	Fintech	600	928	547
2	Healthcare	414	471	370
3	Education	108	146	244
4	Food	287	391	243
5	E-commerce	1257	1764	202
6	Artificial Intelligence	134	127	112
7	Consumer Brands	138	104	73
Top 7 Sectors		2938	3931	1791

Note: *Till June, 6, 2020

Source: Report of the Venture Intelligence -2020 and howindialives.com, 23rd June, 2020

The top sectors presented in Table. 6 reveals that the sector drivers have changed with a negligible changes brought about by the COVID 19. E- commerce is the largest looser as this sector has attracted $1257 million and $1764 million during the first and second half of 2019, could attract only $ 202 million in the first half of 2020, losing more than a billion dollars ($1055 million). This was followed by health care sector by losing $136 million in the first half of 2020, compared to first half of 2019. The sectors like food ($ -44 million), artificial intelligence ($-22 million) and consumer brands ($ -65 million) were also the losers during the first half of 2020, compared to first half of 2019. The venture capital investments have witnessed a decrease to the extent of 39.0 per cent in firsts half of 2020, as compared to first half of 2019 and a decline of 54.4 per cent compared to second half of 2019.

IMPACT OF COVID 19 ON VENTURE CAPITAL

The first case of corona virus was registered on January, 30th in India and the efforts of the Government to overdrive to contain virus were started during the second half of March, 2020. Though there were more investments in Start-Ups during the months of January and February, 2020, after these two months the Start-Ups have experienced the situation of lack of funds and many companies have announced layoffs. April and May, 2020 have proved more brutal for start-ups and the no. of deals have decreased to an average of 50 a month during January and April, to 20 in May and only one- fourth of the investments were made in May, 2020, as compared to May 2019, though there was a slight increase in the month of June, 2020. The details of the drop in venture capital investments in Indian start-ups are presented in Table 7:

TABLE 7: IMPACT OF COVID ON VENTURE CAPITAL :2019 AND 2020

Months	Venture Capital Investments in Indian Start-Ups (in $ Million)		Percentage Increase (+)/ Decrease (–) in 2020 over 2019
	2019	2020	
January	1169	709	-- 39.3
February	281	791	+181.5
March	786	392	-- 50.1
April	574	443	-- 22.8
May	788	202	--74.4
June	640	240	--62.5
For all the months	4238	2777	--34.5

Source: Report of the Venture Intelligence -2020 and www.howindialives.com, 23rd June, 2020

The estimations of drop in venture capital investments, as presented in Table.7, reveals that there was a decline of venture capital investments to the tune of $ 1461 million (34.5 per cent) in the first half of 2020 compared to the first half of 2019. Except for the month of February, for all the 5 months, there was a decline in venture capital investments in Indian Start-Ups and highest decline was registered for the months of May and June.

CONCLUSION

In spite of the availability of vast pool of scientific and technical research abilities, India is still recognized as a low cost developer and service provider. Though India has skilled manpower, advantage of English-speaking human resources and cheap labor, its leadership is on a slipping edge as other countries such as Philippines, China and Vietnam, which are trying to grab the position of India. In recent years, the business activities and operations of the industries are getting more and more technology-oriented. Being attracted by the congenial business environment available in India, many foreign companies are getting located around Delhi, Mumbai, Bangalore, Hyderabad, Visakhapatnam, Tirupati and Sathyavedu, which are offering a good no. of employment opportunities to young, skilled and talented people. It is to be admitted here that there would be a phenomenal increase in start-up industries, which provide employment opportunities, if there would be proper, adequate and effective supply of venture capital funds. This can happen only when the right environment is created to understand the global forces and the operational features of life cycle of borrowing companies and it is sure that we can create a right replica of Silicon Valley in India, a phenomenon for the world to watch. No doubt, the COVID 19 crisis has brought up significant changes in the no. of deals and volume of venture capital investments as well as in start-up investment patterns, there is a shift in their focus from tech-centric start-ups to the ones operating in sectors like FMCG, on-line delivery of essential commodities, entertainment within the house, etc., It is to be noted that start-ups in India like EdTech, FinTech and Cyber Security have been promoting their user demand, forming the important sources of attracting the investors. In addition, the efforts of the Government of India to extend $ 130K for the development of an encrypted video conferencing solution encourage the development of start-ups in India during the post-COVID 19 crisis. Let us hope that the shifts in focus areas as well as the supporting efforts of the Government to unlock the effect of the present health crisis prove fruitful for the increased flow of venture capital investments for the improvements in productivity of the industrial ventures.

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5) For PIPE investments also 2017 was proved as the best year as they have registered highest no. of deals (42) which received investment of US $ 3.8 billion, though an investment of US $ 1.6 billion was invested across 61 deals.

SECTOR-WISE VENTURE CAPITAL INVESTMENTS IN INDIA

A similar view can be seen with regard to the sectoral distribution of venture capital investments in India during the year 2017, which was considered as the best year compared to the year 2016. The important sectors like financial services, real estate, e-commerce, technology, retail and consumer products, and health care recorded the highest ever investments by Venture Capitalists in India. Except for technology, which recorded a decline of 10%, all the other sectors mentioned above grew by over 50% in terms of value. Apart from these, sectors such as logistics, power and utilities and food and agriculture also witnessed good investment activity in 2017. The sector-wise amounts of venture capital attracted are presented in Table.3.

TABLE 3: GROWTH OF INVESTMENTS ACROSS SELECTED SECTORS IN INDIA DURING 2017

S. No.	Sectors Attracted Investments	No. of Deals and Value of Deals (US $ b)			
		Deal Value	% contribution to overall value	No. of Deals	% contribution to overall Deal volume
1	Financial Services	7.2	27	112	19
2	Real Estate	5.0	18	53	9
3	E-Commerce	4.7	17	60	10
4	Technology	1.8	7	121	20
5	Power and Utilities	1.3	5	NA	NA
6	Health care	1.0	4	37	6
7	Retail and Consumer	0.8	3	37	6
8	Others	4.7	18	128	22

Source: EY (2018) PE/VC Agenda, India Trend Book-2018, p. 18

Among the different major sectors that have attracted venture capital, as presented in Table. 3, reveals that Financial Services with US $ 7.2 billion across 112 deals has attracted the highest percentage of contribution to overall value of the deals. This was followed by Real Estate sector contributing 18 % of the overall value estimated as US $ 5.0 billion across 53 deals. E-commerce was the next succeeding sector which has attracted US $ 4.7 billion across 17 deals during the year 2017. Other sectors also proved more effective in attracting the venture capital to the tune of 18% of the overall value, accounting for US $ 4.7 billion across 37 deals. The sectors like technology, health care and retail and consumer have attracted investments ranging from US $1.8 billion to US $ 0.8 billion during 2017 in India.

SECTOR WISE DEAL SIZE-RECENT TRENDS

The experts have observed that the Indian VC industry has passed through three distinct phases in the last decade. The first phase refers to the period from 2012 to 2015, which was called as "Growth Stage". The second phase refers to the period of two years, i.e. 2016 and 2017, called as "Maturing and Moderation" period. The third phase refers to the years 2018 and 2019, called as "Renewed Optimism" period buoyed by marquee exits for investors like Flipkart, MakeMyTrip and Oyo, and a strong start-up activity in new sectors such as Fintech and SaaS along with market depth in e-commerce.

An attempt is made to present the average deal size by sectors during the third phase of passage of Venture Capital funds in India. The details are presented in Table 4:

TABLE 4: THE AVERAGE VC DEAL SIZE BY SECTORS DURING THE 3RD PHASE IN INDIA

Sectors	Average Deal Size ($B)		No. of Deals	
	2018	2019	2018	2019
1. Consumer Tech	11.6	16.9	188	216
2. Fintech	14.3	26.7	71	609
3. Software/SaaS	11.9	12.1	50	88
4. B2B Commerce and Tech	13.2	16.8	38	82

Source: Bain and Company (2020) India Venture Capital Report-2020: Perspectives on the Funding and Start-Up Ecosystem, p.10.

It is evident from the Table.4 that 83.3 per cent of the venture capital investments was concentrated in four sectors like Fintech, Consumer Tech, B2B Commerce and Tech and Software/SaaS. The sector- Fintech was the largest sector accounting for approximately 36.8 per cent of the total investments with 609 deals during the year 2019 followed by Consumer Tech and B2B Commerce and Tech.

GROWTH IN START-UP ECOSYSTEM

It is well known that India has the best start-up ecosystem. A number of initiatives and policy changes like Startup India, Atal Innovation Mission, Digital India and assistance through SIDBI have created a congenial environment for Start-Ups and Venture Capital growth in our country. The estimations revealed that the no. of start-ups have grown at the rate of 17.0 per cent each year from 2015 onwards. The estimated trends in the rapid growth of Start-Up ecosystem in India is presented in Table 5:

TABLE 5: GROWTH IN START-UP ECOSYSTEM IN INDIA (In 100K)

Year	No. of Cumulative Start-Ups	No. of Funded Start-Ups
2015	51	3.6
2016	61	4.6
2017	68	5.4
2018	75	6.0
2019	79	6.4

Source: Bain and Company (2020) India Venture Capital Report- 2020: Perspectives on the Funding and Start-Up Ecosystem, p.22.

The data presented in Table. 5 shows that the no. of cumulative start-ups has increased from 51 to 79 (100K), indicating a percentage increase of 54.9 per cent in 2019 over 2015. Similarly, the no. of funded start-ups has also grown from 3.6 to 6.4 (100K) indicating 77.8 per cent of increase in 2019 over 2015.

IMPLICATIONS OF COVID 19 FOR VC FUNDS

The effect of COVID 19 has also touched the trends in Venture Capital funds. Venture Capital investments in the present financial year are found dropping in terms of no. of deals and value of investments. A comparative picture for the first half of 2019 and 2020 is presented to estimate the impact of COVID 19 on investments by venture capital funds. Table 6 presents the impact of COVID 19.

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STAGES OF INVESTMENT FINANCING

1) Seed capital and Research and Development Projects
2) Start-ups
3) Second Round Finance

1) Development Capital
2) Expansion Finance
3) Replacement Capital
4) Turn Arounds
5) Buyouts

Early stage financing stage need seed capital and the financial risk increases progressively as the research phase moves into the development phase. Venture capital is provided to undertake these risks and make investments in R&D projects which promise higher returns in future. Venture Capital is necessary for start-ups with inadequate finance to commercialize new technology and resultant products. Second round finance meets the financial needs for a company at the stage when the product was launched in the market and has not earned. Adequate profits to attract new investors.

Later stage financing includes development capital to purchase of new equipment plant, expansion of market and launching of product into new regions and loan. Expansion finance focuses on low risk ventures. Buy oust refers to the management control by creating a separate business by separating it from their existing owners. These buyouts include management buyout (MBOs) and management buy ins (MBI). Replacement capital is another aspect of financing is to provide funds for the purchase of existing shares of owners. "Turn arounds" is a form of venture capital financing which involves medium to high risks and buying the control of a sick company.

The venture capitalists evaluate technology and study potential markets besides considering the capability of the promoter to implement the project related to early stage investments. They examine new markets and track record of the business in the later stage investments.

TRENDS OF VENTURE CAPITAL FINANCING IN INDIA

An attempt is made to analyze the trends in Venture Capital Investments made in India during the period 2010 to 2017, based on secondary sources of information. The trends are presented in Table 1:

TABLE 1: TRENDS IN PRIVATE EQUITY/ VENTURE CAPITAL DURING THE PERIOD 2010 TO 2017

Year	Value of Deals (US $ million)	Volume of Deals (No. of Deals)
2010	8430	372
2011	9641	446
2012	7546	416
2013	9116	392
2014	11683	470
2015	19635	767
2016	16203	588
2017	26458	595

Source: EY (2018) PE/VC Agenda, India Trend Book-2018, p.13

The data presented in Table. 1. reveals that during the period 2010 to 2017, there was a significant increase in the flow of Venture Capital Investments as well as in the no. of deals. The value of deals which was US $ 8430 in 2010 has remarkably increased to US $ 26458, with a simultaneous increase in no. of deals from 372 to 595. The year 2017 was treated as the best year in terms of the value of PE/VC investments, as the overall underlying trends of deals becoming larger and more complex.

However, it was observed that the impressive growth in absolute terms was due to the large deals by Softbank from its gigantic US$ 100 billion Vision Investment Fund. In 2017, Softbank made investments worth of US$ 5 billion in the Indian market and most of these investmegts have flown from Vision Fund, particularly for e-commerce Company, Flipkart and also US $ 1.4 billion investments in Paytm and the US $ 1.1 billion investments in Ola Cabs along with Tencent.

A BIRD'S EYE-VIEW OF OTHER DEALS

An analysis is also made to present the other deals and their volume particularly covering start up deals, buyout deals, credit deals, growth deals and PIPE deals and their respective values of deals during the period 2014-2017 in India. Table. 2 presents these details.

TABLE 2: OTHER DEALS AND THEIR RESPECTIVE VALUES IN INDIA DURING 2014-2017

S. No	Investments in	2014		2015		2016		2017	
		No. of Deals	Value (US$b)	No. of Deals	Value (US$b)	No. of Deals	Value (US$b)	No. of Deals	Value (US$b)
1	Start up Deals	253	1.7	454	4.8	300	2.1	372	3.5
2	Buyout Deals	11	1.3	23	3.0	29	3.9	25	3.2
3	Credit Deals	24	0.6	35	1.1	65	2.9	57	2.5
4	Growth Deals	121	6.6	213	8.5	160	5.7	159	13.5
5	PIPE Deals	61	1.6	42	2.3	34	1.6	42	3.8

Source: EY (2018) PE/VC Agenda, India Trend Book-2018, p.16-18

The following observations can be made from the data presented in Table 2:

1) The start-ups deals have recorded highest growth in 2015, with a drop to 300 deals with a value of US $ 2.1in 2016 from 454 deals with US $ 4.8 billion. E-commerce was the sector which has received the largest amount start-up funding at US $819 million.
2) Though the no. of buyout deals was 11 in 2014, picked up momentum from2015 onwards, registering the highest number of 29 in 2016, with a drop to 25 deals. In terms of value of deals also the buyouts registered the highest value of US $ 3.9 billion in 2016, thought it was only US $ 1.3 billion in 2014.
3) Credit deals, which emerged as a new mode of funding in 2016, proved as a viable means of financing for the real estate sector, as can be seen from the data that with 65 deals and representing the value of US $ 2.9 billion in 2016, which has increased from deal value of US$ 0.6 billion in 2014.
4) Growth capital account for more than 50.0 per cent share of the total value invested and the year 2017 was proved as the best year for growth deals which has touched the peak no. of deals with value of US $ 13.5 billion.

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RESEARCH METHODOLOGY

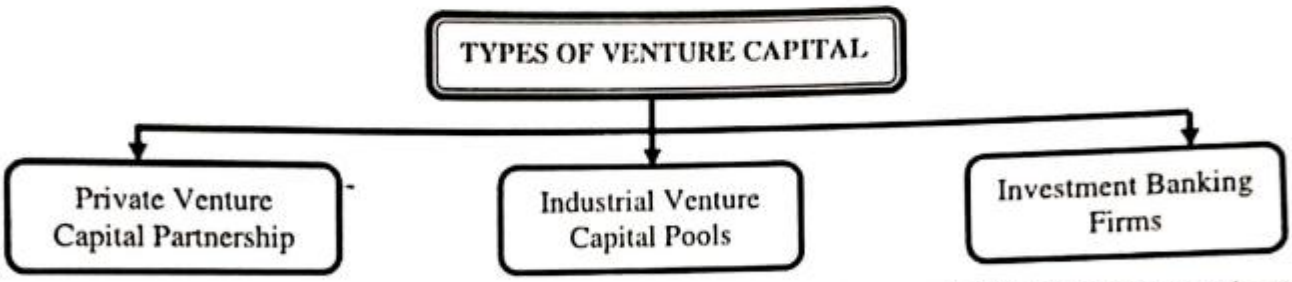
The present analytical study is exclusively based on secondary data sources, focusing on a critical analysis of role of venture capital in financing start ups in India. An attempt is made to examine the recent trends in the performance of venture capital in India. Attention was paid on to present the role of venture capital investments in top sectors and specifically to present the impact of COVID-19 on venture capital investments. To satisfy the objectives mentioned above, relevant secondary data was collected for 11 years i.e. from 2010 to 2020, covering three important kinds of investments, appropriate for three stages of firms/companies in India. Relevant data and insights were gathered from International and National research reports as well as the research papers published in peer reviewed reputed journals like Bain and Company, Venture Intelligence, KPMG, EY, PREQIN PRO etc.

DISCUSSION AND RESULTS

VENTURE CAPITAL AND CONTRIBUTION TO CAPITAL

Venture capital is a form of financing used by start-up and young companies at different stages of growth. Funds flowing into a company in the form of an investment rather than a loan, controlled by an individual or small group known as 'venture capitalists'. Venture capitalists provide large sums of money, advice and prestige by their presence. By obtaining the venture capital backing means that the business would be in the venture capitalist eyes with potential and rapid and profitable growth. Generally, venture capitalists define their investments by the business life cycle seed financing, start-up financing, second stage financing, bridge financing and leverage buyout. If classified by life-cycle of a business, some venture capitalists prefer to invest in start-up companies, featured by high risk and potential for return, same deal with second-stage financing for expansion purposes and same venture capitalists concentrate solely on supplying funds for management-led buyouts.

The following three are the broad types of Venture Capital:



The first type of venture capital is a largest source of risk capital, aims at business which has the capability to generate a 30% return in investment each year. The capitalist like to participate in the planning and management of the business for which funds were invested.

The second type of venture capital focuses on high tech firms or companies that use state of the art technology in a unique manner, which are expected to achieve a high rate of success.

The third type of venture capital provides risk-capital for expansion and early stage financing. In general, venture capital fills the void between sources of funds for innovation-chiefly corporations, government bodies and the entrepreneurs) and traditional lower-cost sources of capital available to ongoing concerns and expects to earn a consistently superior return on investments in inherently risky business ventures.

VENTURES CAPITAL IN INDIA

In India, SEBI has laid down the activities which constitute eligible business activities qualifying for the concessions available to a recognized. Venture Capital Fund. SEBI (VC funds) Regulation -1996 defined venture capital fund as "a fund established in the form of or trust a company having a dedicated pool of capital which raises money through loan, donations, issue of securities or units as the case may be and makes or proposes to make investment in accordance with these regulations." In India, the venture capital funds are playing an important role in supplying management and marketing expertise to unlisted, new and small private business especially in technology-oriented and knowledge-intensive business or industries which might have long development cycles and which usually do not have access to conventional sources of capital. In India the activities of venture capital funds include the provision of:

1) Seed capital for industrial start-ups.
2) Additional capital to new business at various stages of their growth.
3) Equity financing or leverage buy-out financing to management groups for taking over other companies.
4) Bridge Finance
5) Capital to mature enterprises for expansion, diversification and restructuring.

VENTURE CAPITAL IN INDIA

Though in India, a large sophisticated financial system is in operation, in additional to formal institutions, informal financial institutions are playing a dominant role as sources of capital. Venture capital industry in India was introduced through the budget speech for the year 1988. In collaboration with ICICI, the UTI set up a venture capital fund of Rs.20 Crore for fostering industrial development during the year 1988-89. The UTI has launched Venture Capital Unit Scheme (VECAUS-I) to raise resources and with Rs.100 Crore, the second venture capital unit was set up for financing Greenfield ventures.

In 1985, the Risks Capital Funding (RCF) was sponsored by IFCI to provide positive encouragement to new entrepreneurs. It has provided risk capital and technology finance under is roof to innovative entrepreneurs and technocrats for their ventures.

The first private sector venture capital fund was set up by ANZ Grindlays Bank in India with an initial capital of Rs 10cr. In Banking Industry, the subsidiaries of SBI and Canara Bank have started the provision of venture capital funds for the development of industries such as watches, seamless metal, cement and ceramics.

In addition to the regulatory mechanism of SEBI, the government regulations and policy are very congenial for the development of venture capital industry. by sanctioning tax breaks and concessions to the venture capital funds and tax exemptions under section 10(23FB) of IT Act. However, such privileges are not allowed to shareholders of a venture capital company.

FINANCING THE INVESTMENTS TO ENTREPRENEURS

Generally, the venture capital provides funds for long-term under the following three modes of financing:

1) Equity
2) Conditional Loan and
3) Convertible Loans

Under the above three modes, the venture capitalists provide finance for investment to entrepreneurial ventures, particularly related to the sectors like biotechnology, medical services, communications, electronic components, and software companies. To maintain a balance between risk and profitability, venture capital firms finance the following stages of investment requirement.

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DYNAMICS OF GIG-ECONOMY WITH SPECIAL REFERENCE TO DIGITAL PLATFORMS IN INDIA

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ABSTRACT

Our country is emerging as the third largest on-line labour market according to On-line Labour Index Survey and India-based employers represented 5.9 per cent of all projects/tasks posting for online labour of which 45.0 per cent were for software development and technology projects. The highly informal and micro nature of our economy provides impetus to digitally-enabled independent employment opportunities. These forms of work have gained momentum in recent years with the emergence of native and international freelancing platforms. These trends show that the nature and structure of employment in our economy has been undergoing a reformative change towards more independent, freelance on-line jobs. "Gig Economy" is such a new trend in the employment models in these days of digital influences. The present paper deals with this concept of "Gig Economy" with special reference to our economy. The gig economy can be defined as "a free market system where organizations and independent workers engage in short-term work arrangements. Technology has lowered the barriers to entry so much that "gigs" have become easily accessible to an unprecedented number of people. Based on secondary sources of information and statistics, this paper briefly discusses about the traditional job market and the job necessities in the context of the present 4th Industrial Revolution. An attempt is made to discuss about gig and freelance work in India and gig workers' earnings in Top-10 countries along with India. Types of gig work rise of gig economy with its broad segmentation and subsectors. Discussion was also presented about the converging factors responsible for thriving the gig economy in our country, the motivational factors acting as growth drivers of gig economy. The high paying tech-savvy gig jobs in advanced countries and in our country is also present to provide a comparative picture of gig works. The paper concludes with a remark for the necessity of encouragement to be provided for the development of gig economy, keeping in view the unemployment rates both in urban and rural areas with specific reference to women.

KEYWORDS

GIG economy, on-line employment, freelancers, independent work, growth drivers, motivational factors, unemployment rates.

JEL CODES

O32, J22, Q55.

INTRODUCTION

In recent years, the traditional job market and the work-dynamics have been changing allowing greater autonomy and flexibility. The technological disruption has been potentially reshaping the employment landscape by generating opportunities to earn income on-line and better matching of workers with opportunities through digital platforms. The demographic shift and technological developments that are taking place today are demanding rapid job creation to be matched with workers and employers. These shifts are acting as potential drivers of creating opportunities for generating new, relevant and decent jobs for the future of our country. It is argued that the present demand for jobs should be accompanied by the need to create high quality employment opportunities in general and for aspiring youth and women specifically. Digitalization and technological adoption are sound supporting the growth of decent jobs and greater economic inclusion, since employment-generation strategy of our country aims at inclusion of women in the labor market, to erase the gender-bias, which is both a social and economic imperative.

Keeping the approach to strategy of economic development in our country, today, most of the companies are adopting industrial technology and machinery to improve the quality of their output, to maintain their current market position, associated with qualitative improvements in supply-chain management as well as are planning to introduce digital tools and services to attract new customers.

In the context of fast changing business environment and rapid developments in technology, it is necessary for employers to prepare for changes at the workplace. The experts have been observing that there are 10 important workplace trends that are taking place in our country and the companies are found preparing the work force for the future by embracing new developments in labor-market like "Gig-Economy". Gig-Economy consists the gig workers or freelance workers, who work without the frills and collars of traditional jobs, who are called as "Blue Collar Workers". Defined as "Gig Economy", this recent trend presents a distinct strategic opportunity for the organizations of the future, with a specific focus on "Digital Skills" and also on "Digital Platforms". In other words, the "Gig Economy" refers to "labor market activities that are coordinated via digital platforms". Workers take on particular "gigs" without any guarantee of further employment, and the persons who mediate in between these workers and employers, are called as intermediaries, independent contractors and not employers. Generally, the companies operating these platforms are intermediaries, who enable purchasers to order a timed and monetized task from an available worker, by taking a commission, whenever the service is paid for or completer. The Gig Economy operates through two kinds of platforms – "Crowd Work" and "On-demand Work" (Hunt et.al.2017). Crowd Work refers to jobs which are commissioned and carried out virtually, via internet. On-demand work refers to activities which are generally organized through mobile platforms and the jobs are carried out locally with the purchaser and the provider in physical proximity. These jobs are also carried out by text messages or phone calls instead of a mobile platform. Increasing access to internet, increasing number of mobile and smart phone usage and improvements in digital infrastructure have significantly influenced the proliferation of on-line market places and transactions, facilitating a forward movement towards physical world to the digital world. Social networks and cloud computing are found supporting the access to e-commerce transforming cross-border trade in merchandise and services.

As a positive sign being driven by these transformations, "independent work" (flexible work) has gained momentum, both in advanced and developing countries. Independent work is not new to our country since we have the tradition of self-employment- the other term used for independent work, is deeply engrained in our economy and this is reflected in micro-nature of organizations of our country. In this sense, we can use the term "self-employment" as alternative term for "independent work" or gig-based "freelance work".

THE IMPACT OF 4th INDUSTRIAL REVOLUTION

The present century has been witnessing and experiencing the 4th Industrial revolution being propelled by the convergence of a cluster of technologies representing physical, digital and biological impact factors. Machine learning, artificial intelligence, advanced robotics, cloud computing, the IoTs, and block chain etc., are

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evolved and employed for profoundly transforming the future and nature of work in developing and developed economies. Many traditional employment opportunities are found outdated and many are created newly influenced by these modern technologies, embracing and influencing the production processes, business models, service delivery mechanisms, establishing a relationship between generation of employment, flexible working environment, autonomy in working opportunities and decent remuneration to meet the increasing cost of living. Under these transformative conditions, experts, economists, entrepreneurs, employment-model strategists and technocrats are striving to analyze the impact of 4th industrial revolution and are arriving at different arguments and observations, with a specific focus on employment conditions, job displacement and inequalities in labor market in the economies around the globe.

The technology-led employment models that were designed and evolved to suit the requirements of 4th industrial revolution, as they have thought, provide solutions to improve the low productivity and output in the key economic sectors. A variety of strategies were designed for shaping the emerging technologies to play out in the complex socio-economic and cultural contexts of work, among which digital literacy and ICT were recognized as the basic skills required in the current environment of work and to access the public goods and services.

Use of technology has become the major driving force for the present 4th industrial revolution to displace as well as replace the traditional employment opportunities, particularly in India. Of late, the concepts like "Uberization", "Gig-workers" "Independent work", "Freelance Industry", "On-demand Jobs", "Flexible Staffing", "Leased work" and "On-call Workers" are gaining currency in advanced as well as advancing economies. Independent work is on the rise in many advanced economies of Asian, European, North America, Africa, South America and Oceana economies. Asian economies are providing gig work to the estimated tune of 62.0 percent, 18.0 per cent in European economies, and 16.0 per cent in North American economies (On-line labour Index Worker Supplementary-2017). These gig workers are found engaged in software development and technology, creative and multimedia, sales and marketing support, writing and translation, critical and data entry and professional services. According to the On-line Labour Index-2017, India is the largest supplier of online labour and also traditional outsourcing destination. It is estimated that 24.0 per cent of workers are gig workers in India, followed by Bangladesh (16.0 per cent), United States (12.0 per cent), Pakistan (8.0 per cent), Philippines (6.0 per cent) and UK (5.5 per cent). There are four largest online labour outsourcing platforms namely Fiverr, Freelancer, Guru and People Per Hour, which are English language platforms, covering 40.0 per cent of the global gig labor market for platform-based online work. Research efforts were also made to understand the "Gender-dynamics" of Gig Economy for identifying the existing critical knowledge gaps, which are useful of policy makers (Abigail Hunt and Emma Samman, 2019). The research findings indicate that a smaller proportion of women than men are involved in gig work; less regularly work than men and are more likely exit the gig economy. Van Dorn (2017) has analyzed that the gender, racial and class inequalities were acting as dragging forces in the low-wage gig workers. It was estimated that the proportion of women in the gig economy of US accounts to 33.0 per cent to 55.0 per cent, in UK this proportion works out to 31.0 per cent to 52.0 per cent, Germany (39.0 percent), Sweden (39.0 percent) Austria (41.0 per cent) Switzerland (43.0 per cent) and Netherlands (44.0 per cent). The evidence suggests that in many of the economies, women earn less than men through gig work.

MATERIALS AND METHODS

The present paper is exclusively based on secondary sources of information collected from different national and international published reports, research papers and newspapers. The primary purpose of this analytical paper is to explain the concept "Gig-Economy", its features, segmentation, nature of jobs and income offered in general and in our country in particular. The paper focuses on the following objectives:

1. To define and explain the concept "Gig-Economy", its types and segmentation.
2. To introduce the rise of Gig-Economy in India.
3. To analyze the Motivational Factors that drive the performance of Gig-Economy in India.
4. To present the estimates of income offered for the Gig Jobs in India.

RESULTS AND DISCUSSION

GIG-ECONOMY AND FREELANCE WORKERS IN INDIA

The term "Gig" refers to the concept of 'engagement' coined during the financial crisis-2009., when the unemployed made a living by "gigging" or working in several part-time jobs wherever they were available and they could. It was observed that "Gig-Economy" was a sharing economy, open talent economy, freelance economy and also on-demand economy, representing the new paradigm of work. Gig work is characterized by the prevalence of short-term contracts or freelance work as contrary to the permanent jobs in the organized sectors. Technology has been playing an important role in gig-economy as a new business and employment model. The current cutting edge digital on-line platforms along with the proliferation of mobile and smart-phone penetration and application are treated as the important influencing factors for thriving of this gig-economy. By these digital aids, the work assigned to a professional can be completed within the scheduled time and has the flexibility to choose location of the assignments and areas.

Gig economy which is also called as "Flex-economy" or "Mobile Economy" is among the fastest growing employment trends in India along with advanced countries during the recent years. The Global Gig Economy Index-2019 published by "Payoneer" observed that among Top-10 countries, India is emerging as the 3rd largest on-line labor market and the "On-line Labor Index Survey-2016" estimated that India-based employers represented 5.9 per cent of all projects/tasks posting for on-line labor of which 45.0 per cent were for software development and technology projects. The Global Gig Economy Index-2019 also shows that India occupies 7th rank in the year over year revenue growth of gig workers engaged in the economy, as shown in Table. 1.

TABLE 1: TOP-10 COUNTRIES WITH HIGH GIG-WORKER EARNINGS AND REVENUE GROWTH

Rank	Country	% of YoY Growth in Revenue of Gig worker earnings
1	United States of America	78.0
2	United Kingdom	59.0
3	Brazil	48.0
4	Pakistan	47.0
5	Ukraine	36.0
6	Philippines	35.0
7	India	29.0
8	Bangladesh	27.0
9	Russia	20.0
10	Serbia	19.0

Source: Payoneer (2019) Report on The Global Gig Economy Index-2019, p.3

It is evident from the data presented in Table.1 that technology has made easier than ever for individuals to get increased earnings by engaged themselves in profitable gig-work and received favourable rewards. The data shows that India got the 7th rank in terms YoY growth in gig-earnings, accounting for 29.0 per cent among the top-10 countries. However, it is to be noted that India has to make sincere digital efforts to touch the revenue growth of Pakistan (47.0 per cent) as well as the rank of USA (78.0 per cent). As an effort to improve the earnings from gig work in India, it is to be noted that gig economy is churning out of a large number of solopreneurs, micropreneurs and our country has to provide the congenial business and technological environment for the development of gig work.

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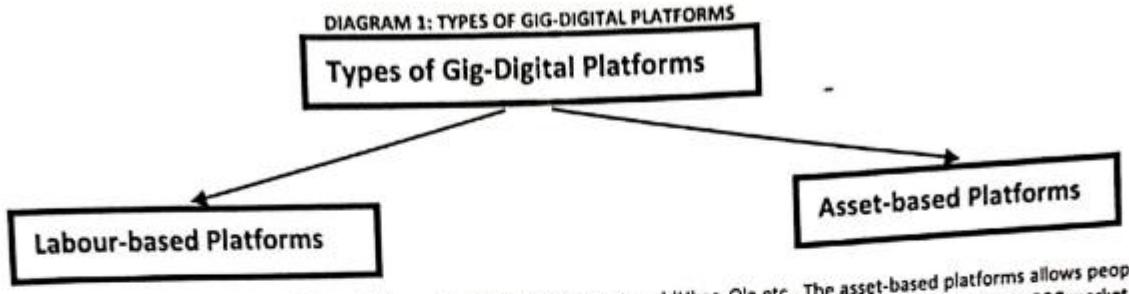
GIG-DIGITAL PLATFORMS

It is to be observed that gig-digital platform can be categorized into two main types in India as shown in the following diagram-1.

DIAGRAM 1: TYPES OF GIG-DIGITAL PLATFORMS

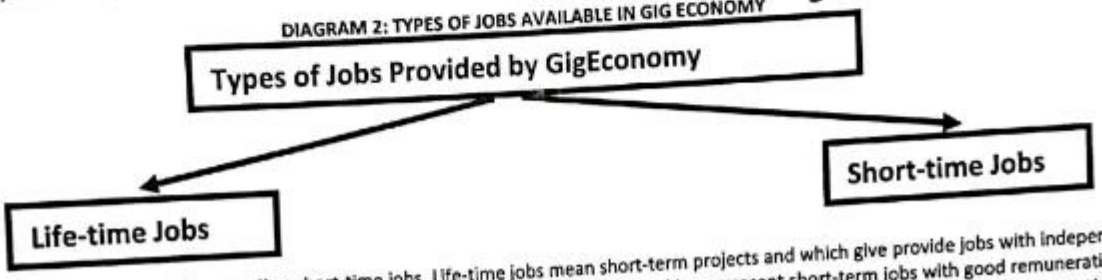


The labour-based platforms enable workers to provide activities and completing tasks assigned (Uber, Ola etc., The asset-based platforms allows people to rent or sell their unused asset (Airbnb, eBay etc., These two platforms have enabled the transformation of the gig economy from a C2C market to B2C market with new models of work and employment. These two kinds of platforms represent gig economy as a broad umbrella term originating from the digital universe of the "Sharing Economy". It is an economy and a novel organization of digital workers, distributed across the economy and organized through task markets and network connections. It is beyond doubt that the rise and advancement of technology has given people more options in the kinds of work they can do in the gig economy. A variety of mobile apps and E-commerce websites like Amazon, Flipkart, Alibaba and Shop clue etc., have proved that anyone can become a merchant and portals like Flexiorg.com, Getmeexperts.com etc., are providing work opportunities for any one with specialized knowledge and skills by connecting them with companies that have such needs.

SEGMENTATION OF GIG ECONOMY

An observation of jobs that are provided by the gig economy can be classified into two types, as shown below in diagram 2.

DIAGRAM 2: TYPES OF JOBS AVAILABLE IN GIG ECONOMY



Gig economy provides both lifetime jobs as well as short-time jobs. Life-time jobs mean short-term projects and which give provide jobs with independence and work flexibility, pay very well and offer future opportunities. Work with only 1 or 2 hours of working represent short-term jobs with good remuneration. The gig job options comprise a variety of digitally-skilled jobs like creative services, content writing, virtual assistance, engineering and architecture, accounting and consulting, software development, automation, artificial intelligence, IoT, ML, IT infrastructure, management, sales and marketing, civil BIM, automobile connected vehicles, PR and Branding, project management and data assembling etc.,

All the modern gig business offers on-line applications to connect individuals seeking jobs/services with those providing jobs and services, fueled by internet startups and a majority of talent managers are found leveraging gig workers in their teams and departments, to drive efficiency, innovation and competitive advantage.

RISE OF GIG ECONOMY IN INDIA

The incentives, schemes and financial assistance provided by Government of India and the creation of SEZ culture, start-ups have flourished in India and 70.0 per cent of the corporate were found using gig workers for solving organizational issues.It was reported by HR professionals and independent consultants interviewed that gig workers were found very useful for supplementing the skills of the existing workforce, reduce the cost of production and fill the temporary vacancies in the firms/organizations/enterprises. The gig workers containing self-employed, freelancers, independent contributors and part-time workers, though represent very much fragmented, got recognition across the globe in general and in India in particular and emerged as a modern workers'-economy, wherein workers come, gig and leave.

In India during the last five years, a large segment-- about 81.0 per cent—has joined the gig economy. Delhi accounts for 43.0 per cent of gig workers, recognized as the biggest hum followed by Mumbai with 19.0 per cent and Benguluru with 18.0 per cent.

Besides the above mentioned two types (as shown in Dig:2), the gig economy can be segmented into the following 4 important categories and with a broad description of each segment is presented in Table. 2

TABLE 2: BROAD SEGMENTATION OF GIG ECONOMY WITH ITs SUB-SECTORS IN INDIA

S. No.	Sector	Description	Subsectors included
1	Asset-Sharing Services	Digital Platforms that facilitate short term P2P rentals of one owner's (or freelancer) property to another individual	Home-sharing Car-sharing Boat- sharing Parking space-sharing P2P Equipment-sharing etc.,
2	Transport-based Services	Digital Platforms that require a freelance driver to complete the requested transport service	Ride-sharing- Car pooling Restaurant Delivery Coupled with guiding skills
3	Professional Services	Digital Platforms that connect freelances directly with business to complete projects	Management skills, Business work, Designing, Coding, Writing/ Translating, Artificial Intelligence, ICT, Cloud computing, Robotics etc.
4	Handmade Goods, Household and Miscellaneous Services (HGHM)	Digital Platforms for freelancers to sell homemade goods/crafts or offer on-demand services for household related jobs.	Home services Baby sitting Handicrafts Tutoring Pet Services and Miscellaneous services etc.,

Source: Master Card and Kalser Associates: (2019) Report of The Global Gig Economy: Capitalizing on a $500 B Opportunity.

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THE CONVERGING FACTORS

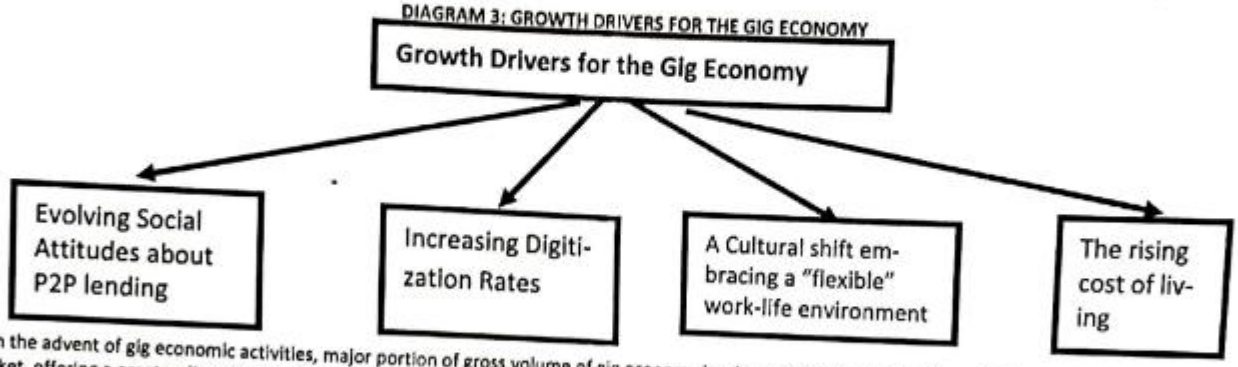
According to the report produced recently by BCG Henderson Group, the following are the factors that are pulling the gig workers towards gig economic activities:

1. Contrary to the mature economies, (1 to 4 per cent), a high proportion of more than 30.0 per cent of workers were found preferring the use of gig work platforms.
2. Job-seekers are entering into gig economy in each and every industry as freelancers.
3. There is a shift in the priorities among workers towards full-time employment as only 20.0 per cent of the freelancers preferred the fulltime employment.
4. The gig work platforms are targeting at workers with a specific level of expertise as well as management consultants, software developers and wellness workers with sophisticated modern skills.
5. 40.0 per cent of the companies, which have absorbed gig workers who have satisfied the characteristics of gig work reported that the gig workers have acted as a complementary source to their regular workforce and the labour productivity in their firms has improved.

THE MOTIVATING FACTORS

According to the recent reports on Gig Economy, the following factors can be listed as "growth drivers" for gig economy in India as shown in Diagram

DIAGRAM 3: GROWTH DRIVERS FOR THE GIG ECONOMY



With the advent of gig economic activities, major portion of gross volume of gig economy has been estimated coming from platforms that were relatively new to market, offering a greater diversity of services to customers, thus enabling the digital industry to expand and mature. The above flow-chart explains the important motivating factors, which acted as the growth drivers for the gig economy and for its expansion. In recent years sharing personal items has been accepted and there is a shift in social attitudes that are encouraging and facilitating of sharing underutilized as well as unutilized assets for profit.

Many digital lending and P2P lending platforms like Lendbox (New Delhi), Faircent (Gurugram), Lending Kart (Ahemadabad), Finzy (Benguluru), i2i Funding (Noida), i-Lend (Hyderabad), LenDen Club (Mumbai), Paisa Dukan (Mumbai), Rupee Circle (Mumbai), Monexo (Mumbai), CashKumar (Benguluru) etc., have been attracting the customers by providing an online marketplace to facilitate peer-to-peer lending by bringing together borrowers and lenders. The consumers are also actively engaged in this lending activity.

The recent trends in rapid smart phone adoption and increased access to internet are found expanding the numbers of eligible gig freelancers. The number of smart phone users is estimated to reach 442.5 million in 2022, which was 199.48 million in 2015. There are 1026.37 million active mobile phone users in our country as on 2018 with 2G,3G and 4G networks. It is also estimated that our country occupies 22nd rank, after China in the number of internet users which was estimated as 560 million and on an average 310 million people in India are spending time with social media accounting for an average of 17 hours per week. It is found that 80.0 per cent of the adults in our country are having at least one digital financial account and according to IMD World Digital Competitiveness Ranking for the year 2019, our country occupied 44th place with the improvement in terms of knowledge and future readiness to adopt and explore digital technologies. It is also observed that work-life adjustments have been considered as important and a cultural shift has been taking place towards embracing a flexible environment altering the workers expectations of a typical 9 to 5 work day. It is also true that in recent times, the cost of living has been increasing alarmingly clubbed with a shrinking share of middleclass families, which is compelling the employed lower to middle class to pursue the sources of supplementary income by engaged in part-time jobs to earn income through gig work to satisfy the needs and demands of the family members.

It is beyond doubt the all the above discussed facts are motivating the people with skills and expertise to pursue the gig economic activities as the best option.

NOT SIDE-HUSTLING WORK

Many workers feel that gig work is a part- time work which offers low income and they are not lucrative. It is a wrong notion and a mistake. The tech-savvy attitude and the skills and expertise fetches high amounts of income by serving a freelancer's option. The study of "FitSmallBusiness.com" observed that the following are the most lucrative options for gig tech-savvy workers. The following Table-3 presents the jobs, their description and the income that can be earned

TABLE 3: TECH-SAVVY GIG JOBS AND THE INCOME OFFERED

S. No.	Name of the Tech-Savvy Gig Job	Income offered per Hour	Description of the Job
1	Deep Learning/ Artificial Intelligence	$ 115.06	Self-Teaching systems, Machine learning, data scientists, software engineers etc.
2	Block Chain Architecture	$ 87.05	Technology used to power, cryptocurrencies, digital currencies etc., It is also known as cloud computing, in which users share data on third-party servers via Google and Microsoft.
3	Robotics	$ 77.46	Includes mechanical and electrical engineering and companies are expanding to develop devices in the medical and surgical fields.
4	Ethical Hacking/ Penetration Testing	$ 66.33	Skills in coding and programming systems-security professionals and Penetration testing.
5	Bit Coin /Cryptocurrency	$ 65.37	Ability to build automated payment tools using altcoins are sought after, including to integrate bitcoin payment technology into existing websites and apps.
6	Amazon Web Services/ Lambada Jobs	$ 51.0	Specialization in AWS Lambada writing and load code for lambada
7	Virtual Reality	$ 50.18	App designing to create digital content that combines visual and audio to create an interactive world in a user's environment, including Development of Algorithms and 3D modeling and Scanning languages.
8	ReactJS Developers	$ 40.75	Companies like Yahoo, Airbnb, and American Express rely on React to allow consumers to make multiple selections on a page (the number of bedrooms in a rental, for example) without needing to reload it.
9	Final Cut Pro Editor	$ 37.12	This professional-grade software allows cutting video clips, altering pace, integrating music, editing scenes, inserting transitions, and more. As an editing freelancer, a gif worker can find work in almost every professional field.
10	Instagram Marketing	$ 31.23	As a marketer and influencer, a Gig worker connects the brands and advertises their products through photos for an agreed-upon fee.

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However, there are some gig works which offer and pay a small amount per hour. Particularly in Data Entry jobs which converts the paper- based books into e-books, in the typing projects and Captcha solving the payment is very low which ranges from Rs. 7 to Rs. 48 in gig platforms like Kolotibablo, Megatypers, Captcha solving websites and MTurk etc.

CONCLUSION

In our country the unemployment rate is estimated at 7.9 per cent on 29th February,2020 according to the data released by CMIE. Urban unemployment rate was estimated as 8.6 per cent it was 7.6 per cent for rural areas. After going through this unemployment rates, it is to be noted that our economy is not able to generate the jobs for the people entering into labour market. Besides, it is to be observed that people in the age group of 15-24 years constitute nearly a fifth of India's total population (2011) and by 2020, they are predicted to make up a third of the country's population. The youth population with the age group of 20-24 years constitute around 40 per cent of India's labor force, have an unemployment rate of 32 per cent and the unemployment rate among the educated is even worse. The World Bank recently estimated that our country needs to create 8.1 million jobs a year to maintain the employment rate. With our demographic dividend and urgency to generate jobs in different sectors of our economy needs immediate attention in the present era of digitalization, which demands high skilled, well-educated and experts in modern technological literacy. The participation of women in the work force in our country is lowest in the world at around 21 percent, as absence of suitable jobs is observed as one of the reasons for this low rate of participation. The report on "Employment Outlook", women gig workers accounted for about 68,000 jobs in the country in 2019 and gig economy has to be resorted for generation of jobs in future. Keeping these unemployment rates, there is every need to support the gig works, which offer not only part-time jobs as well as full-time highly remunerative jobs for tech-savvy freelancers. Referring to the future of jobs in India, EY, FICCI and NASSCOM teams suggested that the jobs in future could be a combination of employee arrangements interspersed with gig working models. The jobs seekers should understand the importance and evaluate the benefits of contractual labor/project-based work arrangements. Gig work should be considered as relevant as any other type of employment and as the primary source of income and have its impact on society, which values stability in work. The Government, while designing the employment generation strategy should keep in mind the requirements of the present digitally-driven technological-dominant labor market to create employment opportunities for the future of India.

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Abstract. The key objective of this analysis is to present the innovative aspects of the thermal radiation and velocity second order slip boundary conditions effects on peristaltic flow under the influence of hall current through a channel. Analytical results are found for the pressure gradient, pressure rise and temperature. An impact of dissimilar governing parameters was deliberated and illustrated diagrammatically through a set of figures. It can be seen that the fluid flow of the axial pressure gradient reduces with an increase in second order slip parameter. We perceive that the pressure rate diminishes in retrograde and peristaltic pumping regions whereas the pumping rate increases in co- pumping region with an increase in second order slip parameter. It can be seen that the temperature of the fluid reduces with an increase in second order slip parameter.

Keywords: Thermal radiation, Second order slip boundary condition, Hall current, Porous medium, Rotation.

1. Introduction

Peristalsis is well known to physiologists to be one of the major mechanisms for fluid transport in many biological systems. Several works about peristaltic motion have been done for a Newtonian fluid. Such approach is true in ureter but it fails to give an adequate understanding of peristalsis in blood vessels, chyme moment in the intestine, semen transport in ductus efferentus of the male reproductive tract, in the transport of spermatozoa and in the cervical canal. In these body organs, the fluid viscosity varies across the thickness of the duct. Also, the assumption that most of the physiological fluid behave like Newtonian fluid is not true in reality. With all these facts in mind, it is clear that viscoelastic rheology is the correct way of properly describing the peristaltic flow.Indepth literature on the present analysis can be found from the references [1-6] and several other therein.According to De Vries et al. [7], they observed that myometrial contractions are peristaltic-type motion and therefore these contractions of the uterine wall may occur in both symmetric and asymmetric directions. Heat transfer is a natural process which occurs quite often in the field of power engineering, refrigeration and air conditioning, chemical engineering, metallurgical engineering etc. They are also widely used in porous industries. Heat transfer is the transition of thermal energy from a region of higher temperature to a region of lower temperature. The transfer of thermal energy continues until the object and its

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surroundings reach the state of thermal equilibrium. The energy transfer by heat flow cannot be measured directly But the concept has physical meaning because it is related to the measurable quantity called temperature. A comprehensive discussion of hall current is given by Cowling [8] Taking Hall current into account the generalized Ohm's Law in the absence of an electric field is of the form. Ajaz Ahmad Dar and Elangovan [9] investigated the influence of an inclined magnetic field and rotation on the peristaltic flow of a micropolar fluid in an inclined channel. In another paper, Abd-Alla and Abo-Dahab [10] in a review paper explained the rotation effect on peristaltic transport of a Jeffrey fluid in an asymmetric channel with the gravity field. TasawarHayat et al. [11] reported on the peristaltic flow of viscous fluid in a rotating channel under the impact of convective boundary conditions. Combined effects of rotation and thermal radiation on peristaltic transport of Jeffrey fluid studied by Hayat et al.[12]. Few relevant studies may be seen via makes attempts [13-16]. Recently Noor Saeed Khan et al. [17] studied the hall current and thermophoresis effects on magnetohydrodynamic mixed convective heat and mass transfer thin film flow.An extension of these studies and for the first time, in this paper we aim to investigate effect of the second slip on the peristaltic flow of physiological fluid flow under the impact of thermal radiation and hall current through a channel. Hence, we focus here on the problem discussed by Nandeppanavar et al. [18], Turkyilmazoglu [19], Rosca and Pop [20]. Effect of the velocity second slip boundary condition on the peristaltic flow of Nanofluids in an asymmetric channel discussed by Emad H. Aly and Abdelhalim Ebaid [21]. Yaqing Liu & Boling Guo [22] studied by effects of second-order slip on the flow of a fractional Maxwell MHD fluid.

2. Formulation of the problem

Consider the physiological fluid flow model of an incompressible viscous fluid through a channel under the impact of second order velocity slip boundary conditions and hall current.A uniform magnetic field B_0 is applied in the transverse direction to the flow. Fig.1 shows the physical model of the problem.

The geometry of the wall surface is labelled by

$$Y = H = b + a\,\mathrm{Sin}\left[\frac{2\pi}{\lambda}(X - ct)\right] \quad (1)$$

In the above equations, a is the wave amplitude of the peristaltic wave, cis the wave velocity, b is the mean half-width of the channel, $\lambda$is the wavelength and t is the time

The transformation between these two frames is given by

$$x = X - ct,\ y = Y,\ u = U - c,\ v = V \text{ and } p(x) = P(X,t)$$

Where (u,v) and (U,V) are the velocity components, p and P are pressures in the wave and fixed frames of reference, respectively.

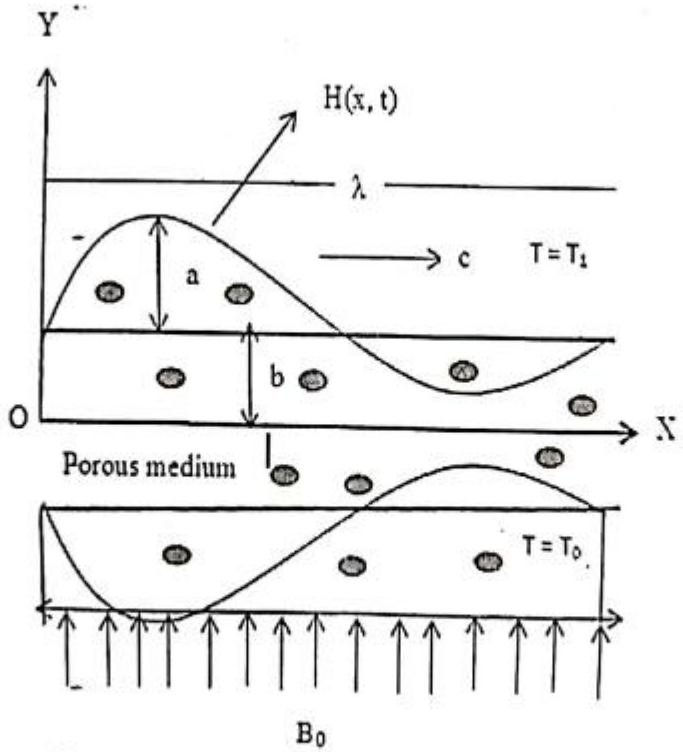

Fig. 1. Schematic diagram of the physical model

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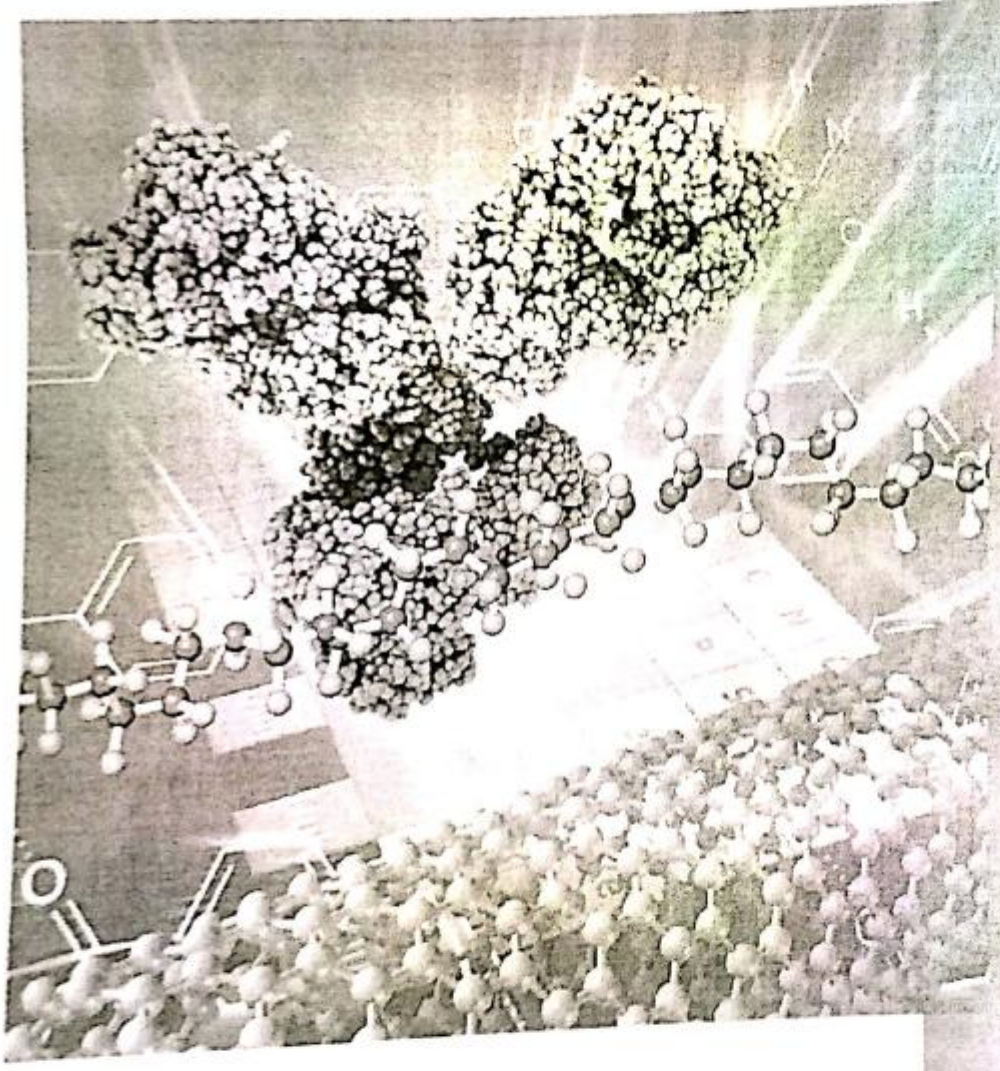

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Design, synthesis and biological evaluation of sulphonamide derivatives of benzofuran-imidazopyridines as anticancer agents

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ABSTRACT

A novel library of sulphonamide derivatives of benzofuran-imidazopyridines (**9a-j**) were designed, synthesized and screened for their anticancer activity against four human cancer cell lines such as breast cancer (MCF-7), lung cancer (A549), colon cancer (Colo-205) and ovarian cancer (A2780) by employing MTT assay. The results are expressed with IC_{50} μM, which indicated that all of the compounds showed good to moderate activity on tested cell lines. Among them, compound **9c** showed potent anticancer activities against MCF-7, A549, Colo-205 and A2780 cell lines with IC_{50} values of 0.011 ± 0.0075 μM, 0.073 ± 0.0012 μM, 0.10 ± 0.19 μM and 0.034 ± 0.0041 μM respectively.

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Specifications Table

Subject area	Organic Chemistry, Biochemistry, Spectroscopy
Compound(s)	Sulphonamide derivatives of Benzofuran-Imidazopyridines
Data category	Spectral
Data acquisition format	NMR, IR, MS(ESI), CHN analysis
Data type	Analyzed
Procedure	Sulphonamide derivatives of Benzofuran-Imidazopyridines as anticancer agents
Data accessibility	Manuscript and supplementary data enclosed with this article

1. Rational

Generally, heterocyclic entities have played crucial roles in the drug design, discovery, pharmacologically active scaffolds, [1-36] and are occupied a fundamental position in synthetic organic and medicinal chemistry [37-39]. After systematic investigation of the heterocyclic compounds, these results indicated that benzofuran contained pharmacologically active agents have played a critical function in the medicinal chemistry. Benzofurans are the most distinguished oxygen atom comprised fused bicycle heterocyclic moieties that are also great medicinal importance because of a present in several natural products [40-42]. In literature survey many re-

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HEAT TRANSFER IMPACTS ON CASSON FLUID FLOW

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Introduction

Ahmadi and Gerold[1] studied on the influence of flow rate, flow behaviour, and particle attention on the heat transfer coefficient of a CuO/water nanofluid each experimentally and theoretically and proved enormous enhancement in the heat transfer coefficient relative to the low concentrations. Buongiorno [2] proposed an alternative rationalization for the extraordinary heat transfer coefficient increases. Hady et al.[3] explored with the flow and heat transfer characteristics of a viscous nanofluid over a nonlinearly stretching sheet in the presence of thermal radiation, covered in the energy equation, and variable wall temperature.Nadeem et al. [4] introduced the modelling of a two-dimensional Williamson fluid for a stretching sheet.Hayat et al. [5] modelled and analyzed by the usage of Rheological expressions of Williamson fluid , the consequence of chemically reactive flow of nanomaterial, involves thermophoresis and Brownian motion.

The intention of the present work is to attain a numerical solution to the boundary layer flow, heat and mass transfer of nanofluid over a cylinder with first order velocity and convective conditions by means of the use of the fourth-order Runge Kutta integration scheme along with shooting process.

Mathematical Formulation

A regular two-dimensional laminar incompressible boundary layer flow of a Casson Williamson fluid flowing upon a stretching cylinder with thermal radiation is regarded in this

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study. Let $U_w(x) = ax/l$ be denote the velocity of the surface, here $a > 0$ is a constant quantity and l is the characteristic length.

$$\tau_{ij} = \begin{cases} 2\left(\mu_f + P_y\sqrt{2\pi}\right)e_{ij} & \pi > \pi_c \\ 2\left(\mu_f + P_y\sqrt{2\pi_c}\right)e_{ij} & \pi < \pi_c \end{cases}$$

In the above equation $\pi = e_{ij}e_{ij}$ and e_{ij} denotes the $(i,j)^{th}$ component of the deformation rate, π be the product of the component of deformation rate itself, π_c be a critical value of this product based on the non-Newtonian model, μ_f be the plastic dynamic viscosity of the Casson fluid and P_y be the yield stress of the fluid.

The governing equations of the fluid flow can be written as

$$\frac{\partial(ru)}{\partial x} + \frac{\partial(ru)}{\partial r} = 0 \qquad (1)$$

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial r} = \upsilon_f\left[\left(1+\frac{1}{\beta}\right)\frac{\partial^2 u}{\partial r^2} + \frac{1}{r}\frac{\partial u}{\partial r} + \frac{\Gamma}{\sqrt{2}r}\left(\frac{\partial u}{\partial r}\right)^2 + \sqrt{2}\Gamma\frac{\partial u}{\partial r}\frac{\partial^2 u}{\partial r^2}\right] - \frac{\sigma B_0^2}{\rho_f}u \qquad (2)$$

$$\left(u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial r}\right) = \frac{\alpha}{r}\frac{\partial}{\partial r}\left(r\frac{\partial T}{\partial r}\right) + \tau\left[D_B\frac{\partial C}{\partial r}\frac{\partial T}{\partial r} + \frac{D_T}{T_\infty}\left(\frac{\partial T}{\partial r}\right)^2\right] + \frac{1}{(\rho C_p)_f}\left(-\frac{1}{r}\frac{\partial}{\partial r}(rq_r) + \mu\left(\frac{\partial u}{\partial y}\right)^2 + \sigma B_0^2 u^2\right) \qquad (3)$$

where u and v are the components of velocity of the fluid in the $x, y-$ axes respectively, the electric charge density is σ, the magnetic induction is B_0, $\upsilon_f = \frac{\mu_f}{\rho_f}$ is the kinematic viscosity of the fluid, μ_f is the dynamic viscosity, the density of the fluid is ρ_f and T is the surface temperature parameter. The temperature on the wall is T_w and C_w is the concentration of the wall, U_w is the stretching velocity, U_∞ is the free stream velocity and the ambient is held at constant temperature T_∞ and constant concentration C_∞, q_r is the radiative heat flux. The

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thermal diffusivity is $\alpha = \frac{k}{(\rho C_p)_f}$, the ratio between the effective heat capacity of the nanoparticle material and heat capacity of the base fluid is $\tau = \frac{\rho C_p}{(\rho C_p)_f}$,

$$u = U_\infty(x) + \left(1 + \frac{1}{\beta}\right)\frac{\partial u}{\partial r},\ v = 0,\ -k\frac{\partial T}{\partial r} = h_f(T_w - T),\ \text{at } r = R,$$
$$u \to 0,\ T \to T_\infty,\ \text{as } r \to \infty \tag{5}$$

q_r is the radiative heat flux and by using the Roseland approximation it is written as:

$$q_r = -\frac{4\sigma_s}{3k_e}\frac{\partial T^4}{\partial r} \tag{6}$$

Where σ_s the Stephen Boltzmann constant and the mean absorption coefficient are is k_e.

The term T^4, is written as a linear combination of temperature. Taylor series may be used forexpanding T^4, about a free stream temperature T_∞ and deleting terms of higher-order, we obtain:

$$T^4 \cong 4T_\infty^3 T - 3T_\infty^4 \tag{7}$$

Then the radiation term in equation (3) converted to the following form

$$\frac{\partial q_r}{\partial r} = -\frac{16\sigma_s T_\infty^3}{3k_e}\frac{\partial^2 T}{\partial r^2} \tag{8}$$

Substituting equations (6) and (8), equation (3) gets modified as

$$u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial r} = \left(\alpha + \frac{16\sigma_s T_\infty^3}{3k_e(\rho C_p)_f}\right)\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\left(\alpha + \frac{16\sigma_s T_\infty^3}{3k_e(\rho C_p)_f}\right)\frac{\partial T}{\partial r}$$
$$+\tau\left[D_B\frac{\partial C}{\partial r}\frac{\partial T}{\partial r} + \frac{D_T}{T_\infty}\left(\frac{\partial T}{\partial r}\right)^2\right] + \frac{1}{(\rho C_f)_f}\left(\mu\left(\frac{\partial u}{\partial r}\right)^2 + \sigma B^2 u^2\right) \tag{9}$$

Let $\psi(x,r)$ be a stream function in the flow field. Here $u = \frac{1}{r}\frac{\partial \psi}{\partial r}, v = -\frac{1}{r}\frac{\partial \psi}{\partial x}$.

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Theequationof continuity (1) is satisfied by the above functions.

The suitable similarity transformations are considered as:

$$\eta = \sqrt{\frac{a}{l\upsilon_f}}\left(\frac{r^2 - R^2}{2R}\right), \psi = \sqrt{\frac{a\upsilon_f}{l}}\, xRf(\eta), \theta(\eta) = \frac{T - T_\infty}{T_w - T_\infty}$$

$$Nt = \tau D_t \frac{T_w - T_\infty}{T_\infty \upsilon_f}, Nb = \tau D_b \frac{C_w - C_\infty}{\upsilon_f}, M = \frac{\sigma B_0^2 l}{\rho_f a}, \quad Rd = \frac{4\sigma_s T_\infty^3}{k_s k}, \quad \Pr = \frac{\upsilon_f}{\alpha}, \tag{10}$$

Using these similarity transformations, the governing equations (2), (3) and (9) aretransformed into the following form:

$$\left(1 + \frac{1}{\beta}\right)(1 + 2n\eta) f''' + n\left(2 + \frac{1}{\beta}\right) f'' + ff'' - f'^2 - Mf' + \frac{3}{2}(1 + 2n\eta)^{\frac{1}{2}} n\lambda f''^2 + \lambda(1 + 2n\eta)^{\frac{3}{2}} f'' f''' = 0 \tag{11}$$

$$\left(1 + \frac{4}{3}\mathrm{Rd}\right)\left((1 + 2n\eta)\theta'' + 2n\theta'\right) + \Pr\left(f\theta' - f'\theta + Ecf''^2 + M\,Ec\, f'^2 + (1 + 2n\eta)(Nb\theta'\phi' + \mathrm{Nt}\,\theta'^2)\right) = 0 \tag{12}$$

Here n is the Curvature parameter, M is the Hartmann number, the radiation parameter is Rd , $\Pr$ is the Prandtl number, Sc is the Schmidt number, the thermophoresis parameter is Nt , Nb are the Brownian motion parameter and λ Wiesenberger number. Now the boundary conditions become to the following form:

$$\left.\begin{aligned} &f(0) = 0, f'(0) = 1 + \alpha_1\left(1 + \frac{1}{\beta}\right) f''(0), \theta'(0) = -\mathrm{Bi}_1(1 - \theta(0)), \\ &\text{at } \eta = 0, \\ &f'(\eta) \to 0, \theta(\eta) \to 0, \text{ as } \eta \to \infty \end{aligned}\right\} \tag{14}$$

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Where $\alpha_1 = \frac{\gamma}{R}\sqrt{\frac{a}{\upsilon_f}}$ the first-order velocity is slip parameter. $\mathrm{Bi}_1 = \frac{h_f}{k}\frac{R}{r}\sqrt{\frac{\upsilon_f}{a}}$ is the thermalBiot number $\mathrm{Bi}_2 = \frac{k_m}{D_m}\frac{R}{r}\sqrt{\frac{\upsilon_f}{a}}$ is the concentration Biot number. The skin frictioncoefficient C_f, the local Nusselt number Nu_x and the local Sherwood number Sh_x arestudied. These parameters denote the surface drag, wall heat transfer rate and mass transferrate respectively. The definitions of these quantities are given by:

$$C_f = \frac{2\tau_w}{\rho U_w^2}, Nu_x = \frac{xq_w}{k(T_w - T_\infty)}, \tag{15}$$

In which $\tau_w = \left(1+\frac{1}{\beta}\right)\mu_f\left(\frac{\partial u}{\partial r}\right)_{r=R}, q_w = -k\left(1+\frac{16\sigma^* T_\infty^3}{3k^* k}\right)\left(\frac{\partial T}{\partial r}\right)_{r=R}$,

$q_m = -D_m\left(\frac{\partial T}{\partial r}\right)_{r=R}$ (16)

While the non-dimensional definitions of skin friction coefficient, Nusselt number andSherwood number are written as:

$$\mathrm{Re}_x^{\frac{1}{2}} C_f = \left(1+\frac{1}{\beta}\right) f''(0), \mathrm{Nu}_x \mathrm{Re}_x^{-\frac{1}{2}} = -\left(1+\frac{4}{3}Rd\right)\theta'(0), \tag{17}$$

Where $\mathrm{Re}_x = \frac{U_w(x)x}{\upsilon_f}$ is the local Reynolds number?

Results and Discussion

This study analyzes the impacts of the important physical parameters on dimensionless velocity, temperature distribution, and non-dimensional concentration profiles with the help of the graphs and tables. To obtain the desired accuracy, we have compared our results with previously published results by Gnaneswara Reddy et al. [6].Our results agreed with the previous results as illustrated in **Table 1**The following values are taken for important parameters in calculation.

$M = Rd = 0.5, \alpha_1 = Bi_1 = Bi_2 = \beta = Nt = Nb = \lambda = 0.1, \mathrm{Pr} = 3, Sc = 10, n = 0.12$

Table 1: Comparison of values of Skin friction coefficient $-f''(0)$ with previous results, when $Pr = \alpha_1 = Bi_1 = Bi_2 = Nt = Sc = Rd = \beta = \lambda = 0$, $Nb = 0.000001, n = 0.12$

M	Gnaneswara Reddy et al. [22]	Present results
0	-1	-1
0.5	1.1180331	1.1180332
1.0	1.4142135	1.4140133
5.0	2.4494896	2.4414678
10.0	3166241	3166231

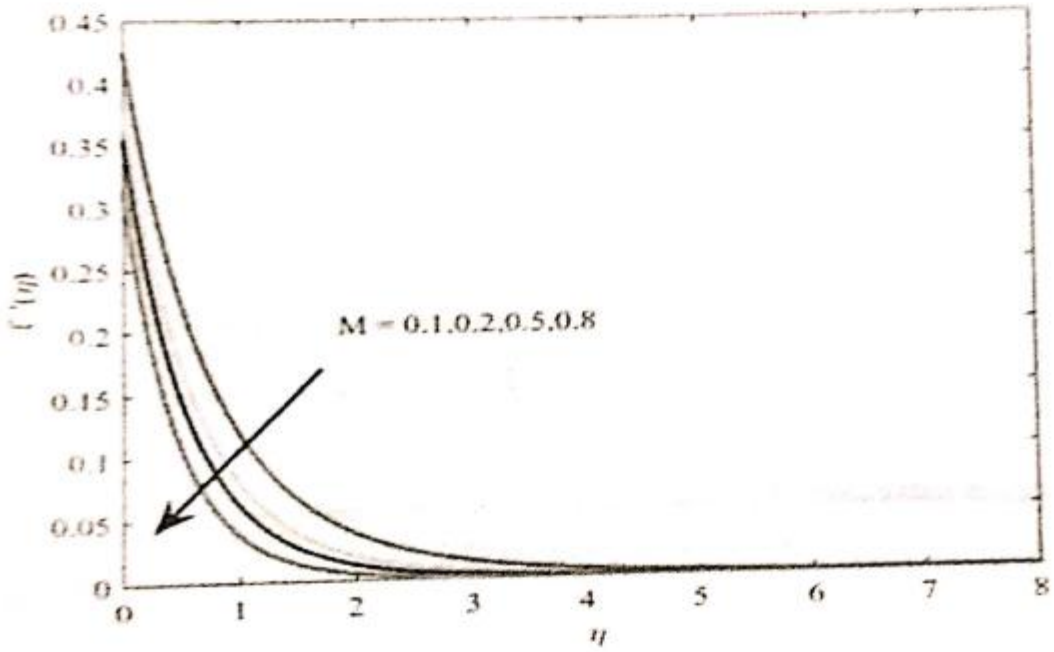

Fig.2 Influence of M on velocity profile.

Fig.2 exhibits the decreasing nature of the velocity profile $f'(\eta)$ and also the boundary layer thickness for higher values of M. This indicates that the increase in M helps to thin of the boundary layer. The velocity profiles exponentially reduce to zero at shorter distances from the sheet for growing values of M.

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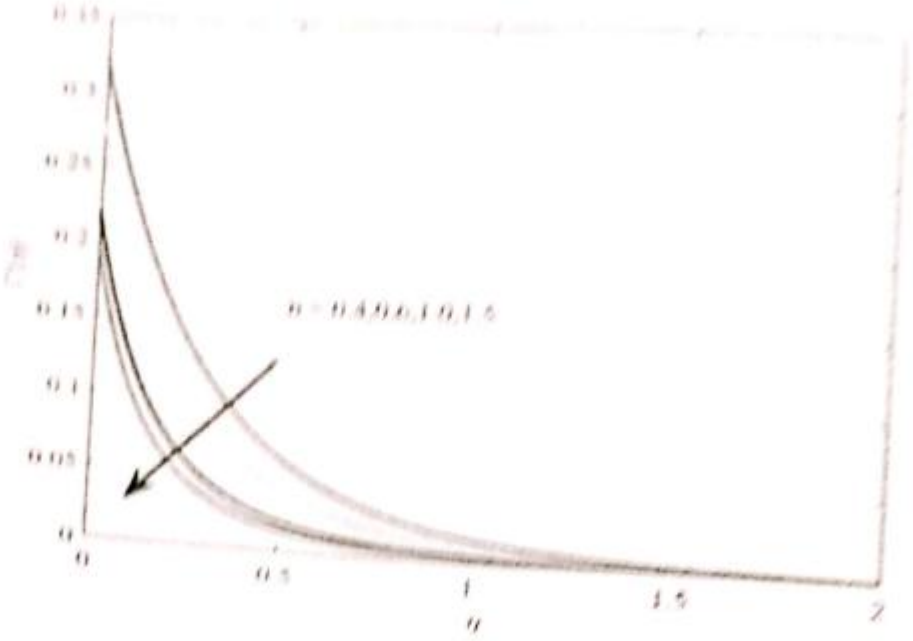

Fig.3 Influence of n on velocity profile

Fig.3 shows the impact of the curvature parameter on non-dimensional velocity distribution $f'(\eta)$. A rise in the curvature parameter results , decrease in the nondimensional velocity. Resistance force is created by the magnetic field on the fluid in the boundary layer. This force causes restriction to the motion of the fluid. So the magnetic parameter reduces the dimensionless velocity.

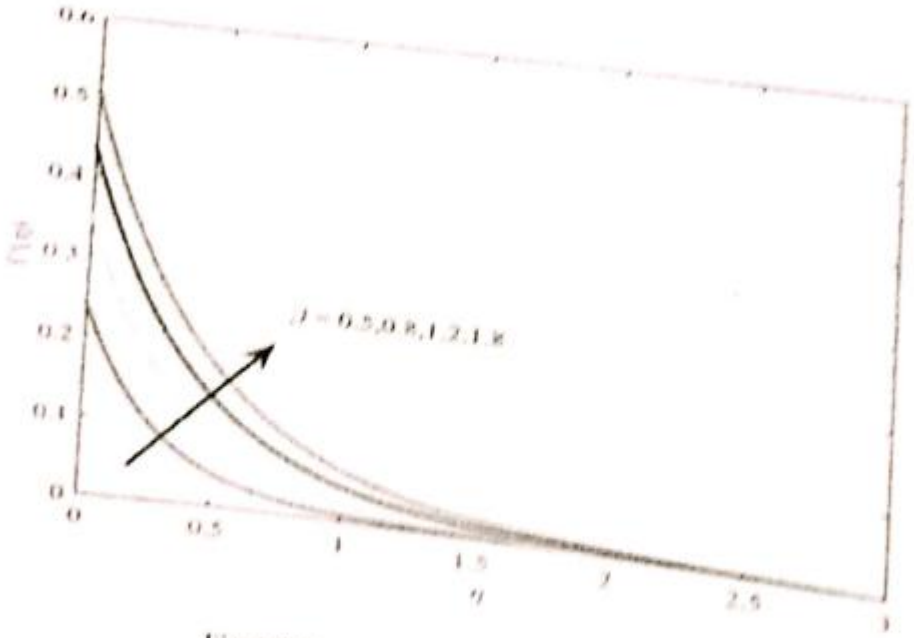

Fig.4 Influence of M on velocity profile

Fig.4 explicates the increasing nature of velocity profile for rising values of Casson fluid parameter.

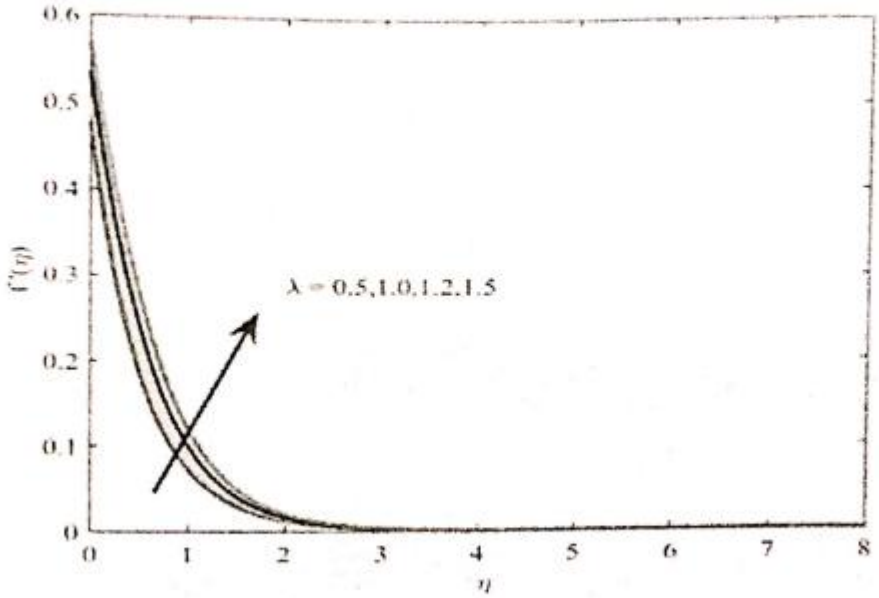

Fig.5 Influence of λ on velocity profile.

Fig.5 illuminates the effect the Wiesenberger number λ on velocity profile. It depicts the velocity profile increased with the increment of λ .

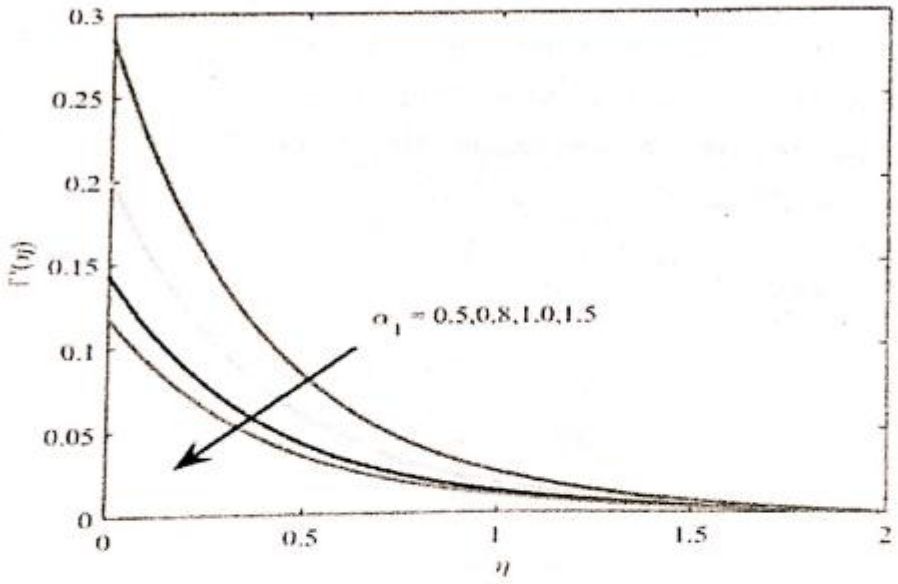

Fig.6 Influence of α_1 on velocity profile.

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Fig.6 explains the influence of first-order velocity slip parameter on the dimensionless velocity profile $f'(\eta)$. The dimensionless velocity profile $f'(\eta)$ decreases with increasing values of the first-order velocity slip parameter α_1.

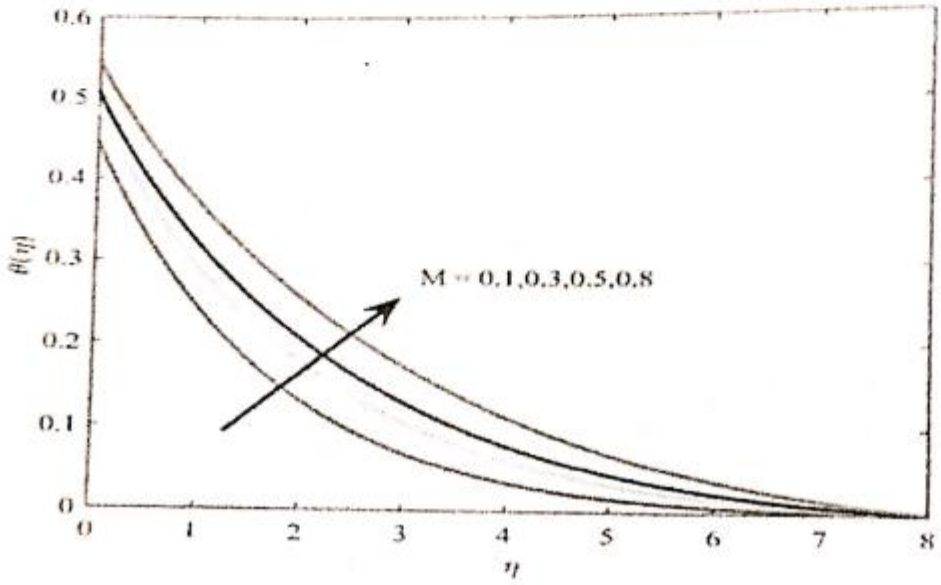

Fig.7 Influence of M on temperature profile.

Fig.7 represents the impact of the magnetic parameter on energy distribution. The effect of magnetic field reduces the fluid velocity whereas it intensifies thermal boundary layer thickness. Thermal energy is defined as an additional work done required for dragging the fluid under the influence of the magnetic field. Thermal energy heats up the conducting fluid and upgrades the temperature profile. Thus, the magnetic field in the flow regime intensifies the thermal boundary layer thickness.

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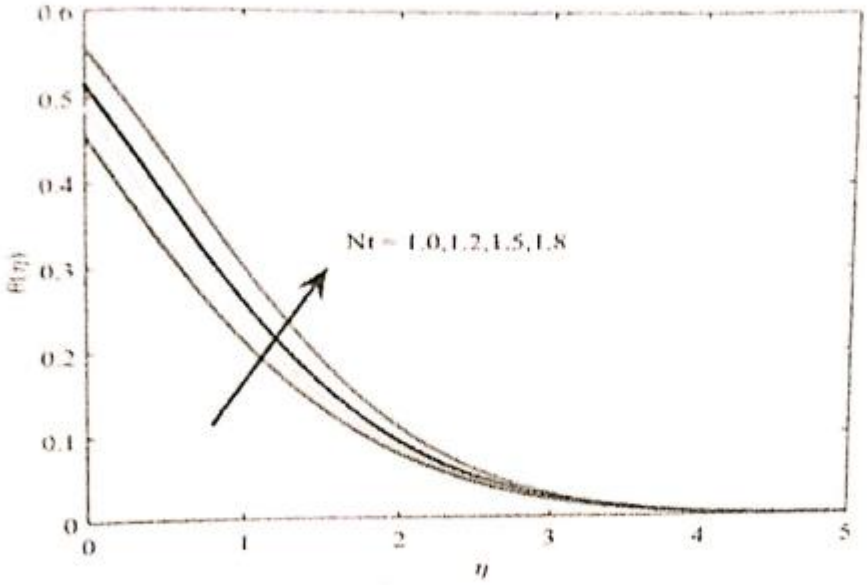

Fig.8 Influence of Nt on temperature profile.

Fig.8 exhibits the influence of the thermophoresis parameter on temperature profile. The energy distribution grows with increment in the values of the thermophoresis parameter.

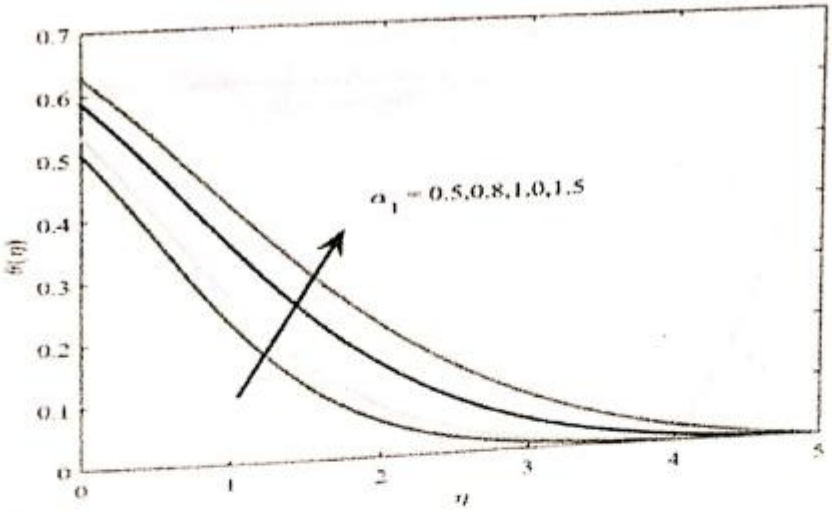

Fig.9 Influence of α_1 on temperature profile.

The impact of first-order velocity slip parameter on temperature profile is explained in Fig.9, the temperature rises with a rising in first-order velocity slip parameter.

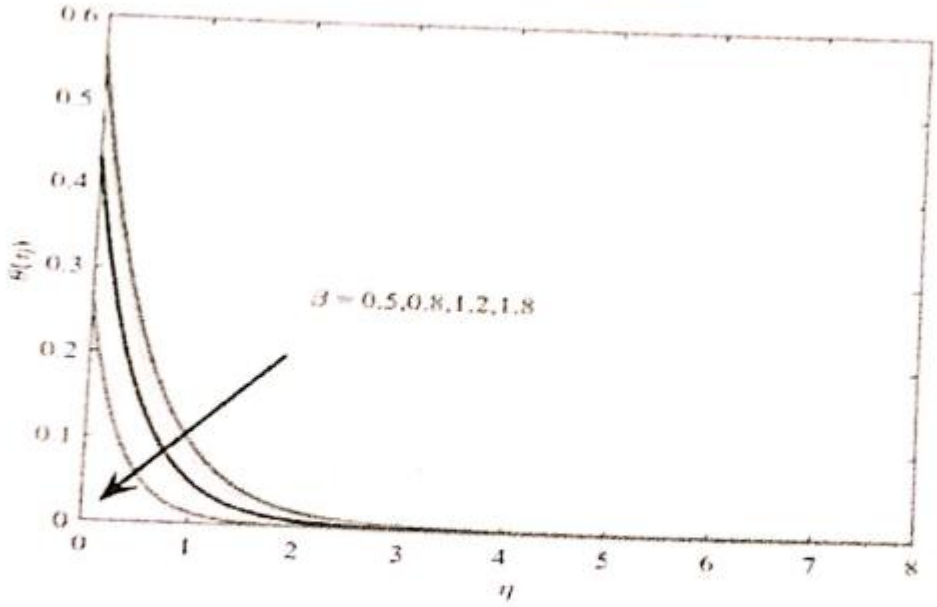

Fig.10 Influence of β on temperature profile.

Fig.10 exhibits the influence of Casson fluid parameter on temperature profile. There is a decrease in temperature profile for increasing values of Casson fluid parameter.

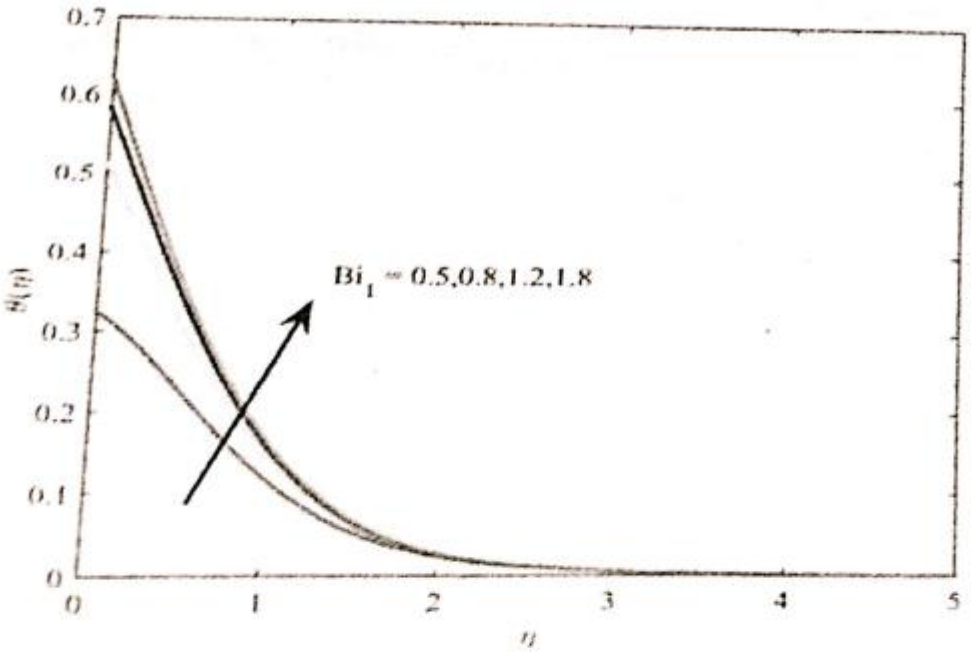

Fig.11 Influence of Bi_1 on temperature profile.

Fig.11 represents the influence of thermal Biot number on temperature profile. There is an increment in temperature profile for increasing values of thermal Biot number.

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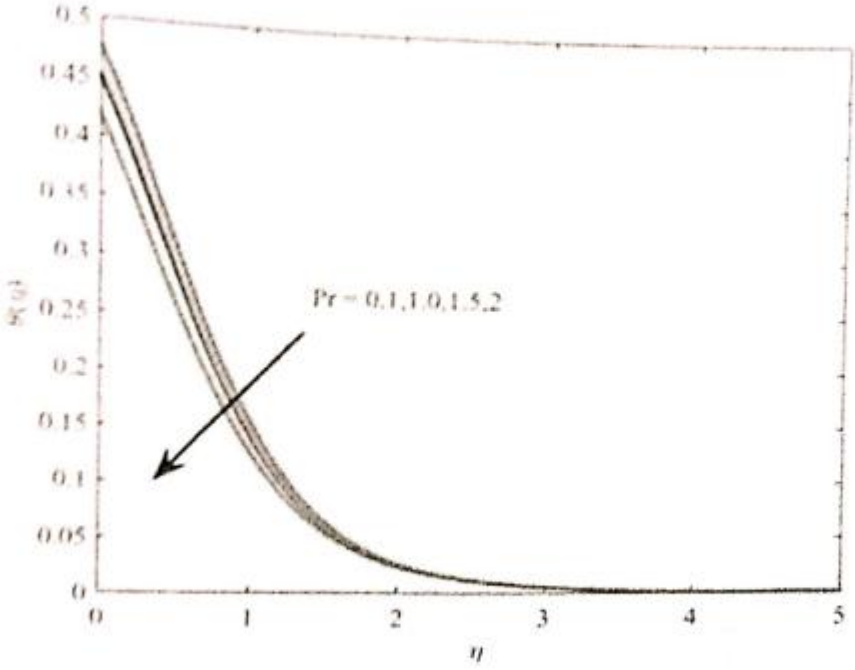

Fig.12 Influence of $\Pr$ on temperature profile.

The impact of Prandtl number on the thermal boundary layer is drawn in Fig.12 the Prandtl number is a material property. This number varies from one fluid to another fluid. It is inversely proportional to thermal conductivity and directly proportional to viscosity. Increasing values of this number reduce the thermal diffusivity. Consequently, the heat flows below the fluid. And the thermal boundary layer thickness reduces with growing values of

5 CONCLUSION

In the present chapter, the numerical investigations have been carried out the boundary layerflow, heat transfer of Williamson Casson nanofluid over a cylinder with first-order velocity slip,thermal and concentration Biot numbers. Discussion about the impacts of different emergingparameters on velocity profile $f'(\eta)$, temperature distribution $\theta(\eta)$, theskin friction coefficient, Nusselt number is done with the help of plotsand numerical results are tabulated. The key observations of this studyare shortly written as:

1. Thenvelocity intensifies with increasing values of Casson parameter, Weissenberg number and a reverse behavior is found to be true with increasing values of Magnetic parameter, curvature parameter, first order velocity slip parameter.

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Research Article

A BRIEF LITERATURE ON PROBLEMS AND PERSPECTIVES OF MATHEMATICAL AND STOCHASTIC MODELLING

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Abstract: This research article mainly explores on problems and perspectives of mathematical and stochastic modeling. There is a large element of compromise in mathematical modelling. The majority of interacting systems in the real world are far too complicated to model in their entirely.In this research paper an extensive discussion has been made on linear models,nonlinear models,static models,dynamic models.A comparative study is done between the pairs explicit and implicit model,discrete and continuous model,deterministic and probabilistic model. In this talk a brief discussion on different types of models has been proposed and the concept of stages of model building is extensively discussed.Problems of stochastic model building are presented in a lucid manner and this literature is highly helpful for young researchers in stochastic modeling.

Keywords:Linear and nonlinear model,Static and dynamic model,Model bulding,Stochastic modeling,Explicit and Imlicit model,

1.Introduction

Modelling is a cyclic process of creating and modifying models of empirical situations to understand them better and improve decisions. The role of modelling and mathematical modelling has received increasing attention as generating authentic learning and revealing the ways of thinking that produced it. We review a subset of the related literature; discuss benefits and challenges in teaching and learning mathematical modeling activities and implications for instruction and assessment as well as for research.

Models describe our beliefs about how the world functions. In mathematical modelling, we translate those beliefs into the language of mathematics. This has many advantages.

(1) Mathematics is a very precise language. This helps us to formulate ideas and identify underlying assumptions.
(2) Mathematics is a concise language, with well defined rules for manipulations.
(3) All the results that mathematicians have proved over hundreds of years are at our disposal.
(4) Computers can be used to perform numerical calculations.

There is a large element of compromise in mathematical modelling. The majority of interacting systems in the real world are far too complicated to model in their entirely. Hence, the first level of compromise is to identify the most important parts of the system. The second level of compromise concerns the amount of mathematical manipulation which is worthwhile. Although mathematics has the potential to prove general results, these results depend critically on the form of equations used. Small changes in the structure of equations may require enormous changes in the mathematical methods. Using computers to handle the models equations may never lead to elegant results, but it is much more robust against alterations.

2. METHODOLOGICAL MODELING PRINCIPLES

Mathematical modelling is a principled activity that has both principles behind it and methods that can be successfully applied. The principles are over-arching or meta-principles phrased as questions about the intentions and purposes of mathematical modelling. These meta-principles are almost philosophical in nature.

Methodological modeling principles are also captured in the following list of questions and answers:

- What are one looking for? Identify the need for the mode.
- What do one wants to know? List the data we are seeking.
- What do one knows? Identify the available relevant data.
- What can one assume? Identify the circumstances that apply.

- How should one look at this model? Identify the governing physical principles.
- What will model predict? Identify the equations that will be used, the calculations that will be made, and the answers that will results.
- Are the predictions valid? Identify tests that can be made to validate the model, i.e., is it consistent with its principles and assumptions?
- Are the predictions good? Identify tests that can be made to verify the model, i.e., is it useful in terms of the initial reason it was done?
- Can one improve the model? Identify parameter values that are not adequately knows, variables that have been included, and / or assumptions / restrictions that could be lifted. Implement the iterative loop that one can call "model-validate-verify-improve-predict."
- How will one exercise the model? What will one do with the model?

This list of questions and instructions is not an algorithm for building a good mathematical model. However, the underlying ideas are key to mathematical modelling, as they are key to problem formulation generally. Thus, one should expect the individual questions to recur often during the modeling process, and one should regard this list as fairly general approach to ways of thinking about mathematical modelling.

Having a clear picture of why the model is wanted or needed is or prime importance to the model-building enterprise. Defining the task is the first essential step in model formulation.

If one finds that the model is inadequate or that it fails in some way, then one may enter an iterative loop in which one returns to an earlier stages of the model building and re-examine assumptions, known parameter values, the principles chosen, the equations used, the means of calculation, and so on. This iterative process is essential because it is the only way that models can be improved, corrected, and validated.

3. CLASSIFICATION OF MATHEMATICAL MODELLING

A model which uses a large amount of theoretical information generally describes what happens at one level in the hierarchy by considering processes at lower levels; these are called mathematical models because they take account of the mechanisms through which changes accur. In empirical models, no account is taken of the mechanism by which changes the system occur. Instead it is merely noted that they do occur, and the model tries to account quantitatively for changes associated with different conditions.

The two divisions above namely deterministic and mechanistic / empirical represent extremes of a range of model types. In between lie a whole spectrum of model types. Also, the two methods of classification are complementary. For Example, a deterministic model may be either mechanistic or empirical (but not stochastic)

One further type of model, the system model, is worthy of mention. This is built from a series of sub-models, each of which describes the essence of some interacting components. The above method of classification then refers moreproperly to the sub-models; different types of sub-models may be used in any one system model.

Much of the modelling literature refers to 'simulation models'

(a) Mathematical models may be classified according to the subject matter of the models. Thus one may have mathematical models (M.M) in chemistry (Theoretical Chemistry); M.M in Biology (Mathematical Biology), M.M in Medicine (Mathematical Medicine), M.M in economics (Mathematical Economics and Econometrics), M.M in Psycholcgy (Mathematical psychology), M.M. in sociology (Mathematical Sociology), M.M. in Engineering (Mathematical Engineering) and so on.

One may have similarly M.M. of transportation, of urban and regional pollutions, of population, of environment, of oceanography, of blood flows, of genetics, of water resources, of optimal utilization of exhaustible and renewable resources, of political systems, of land distribution, of linguistics and so on.

In fact, every branch of knowledge has two aspects one of which is theoretical, mathematical, statistical, and computer based and the other of which is empirical, experimental and observational. Mathematical Modeling is essential to the first of these aspects.

(b) One may also classify mathematical models according to the mathematical techniques used in solving them. Thus one may have mathematical modeling (M.M) through classical algebra, M.M. through linear algebra and matrices, M.M. through ordinary and partial differential equations, M.M through ordinary and partial difference equation, M.M. through functional equations, M.M. through

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graphs, M.M. through mathematical programming, M.M. through calculus of variations, and M.M. through maximum principle and so on.

(c) Mathematical models may be linear or Non-linear according as the basic equations describing them are linear or nonlinear. Mathematical models may also be classified according to the purpose we have for the model. Thus, one may have Mathematical Models (M.M.) for Description, M.M for Insight, M.M for prediction, M.M for optimization, M.M for control and M.M for Action.

(d) Mathematical models may also be classified according to their nature,

Mathematical models are usually composed of relationships among variables. Relationships can be described by operators, such as algebraic operators, functions, differential operators, etc. Variables are abstractions of system parameters of interest, that can be quantified. Several classification criteria can be used for mathematical models according to their structure:

- **Linear vs. Nonlinear Models:** If all the operators in a mathematical model exhibit linearity, the resulting mathematical model is defined as linear. A model is considered to be nonlinear otherwise. The definition of linearity and nonlinearity is dependent on context, and linear models may have nonlinear expressions in them. For example, in a statistical linear model, it is assumed that a relationship is linear in the parameters, but it may be nonlinear in the predictor variables. Similarly, a differential equation is said to be linear if it can be written with linear differential operators, but it can still have nonlinear expressions in it. In a mathematical programming model, if the objective functions and constraints are represented entirely by linear equations, then the model is regarded as a linear programming model. If one or more of the objective functions or constraints are represented with a nonlinear equation, then the model is known as a nonlinear programming model.

- **Static vs. Dynamic Models:** A dynamic model accounts for time-dependent changes in the state of the system, while a static (or steady-state) model calculates the system in equilibrium, and thus is time-invariant. Dynamic models typically are represented by differential equations.

- **Explicit vs. Implicit Models:** If all of the input parameters of the overall model are known, and the output parameters can be calculated by a finite series of computations (known as linear programming, not to be confused with linearity as described above), the model is said to be explicit. But sometimes it is the output parameters which are known, and the corresponding inputs must be solved for by an iterative procedure, such as Newton's method (if the model is linear) or Broyden's method (if nonlinear).

- **Discrete vs. continuous Models:** A discrete model treats objects as discrete, while a continuous model represents the objects in a continuous manner.

- **Deterministic vs. probabilistic (stochastic) Models:** A deterministic model is one in which every set of variables states is uniquely determined by parameters in the model and by sets of previous states of these variables; therefore, a deterministic model always performs the same way for a given set of initial conditions. Conversely, in a stochastic model-usually called a "statistical model"-randomness is present, and variable states are not described by unique values, but rather by probability distributions.

- **Deductive, Inductive, or Floating Models:** A deductive model is a logical structure based on a theory. An inductive model arises from empirical findings and generalization from them. The floating model rests on neither theory nor observation, but is merely the invocation of expected structure.

Linear, static and deterministic models are usually easier to handle than non-linear, dynamic and stochastic models and in general in any discipline these are the first to be considered.

4. STAGES OF MODEL BUILDING

The various steps involving in the model building can be characterized as:

(i) examining the situation and setting up the goals to be accomplished;
(ii) identifying variables in the situation and selecting those that represent essential features;

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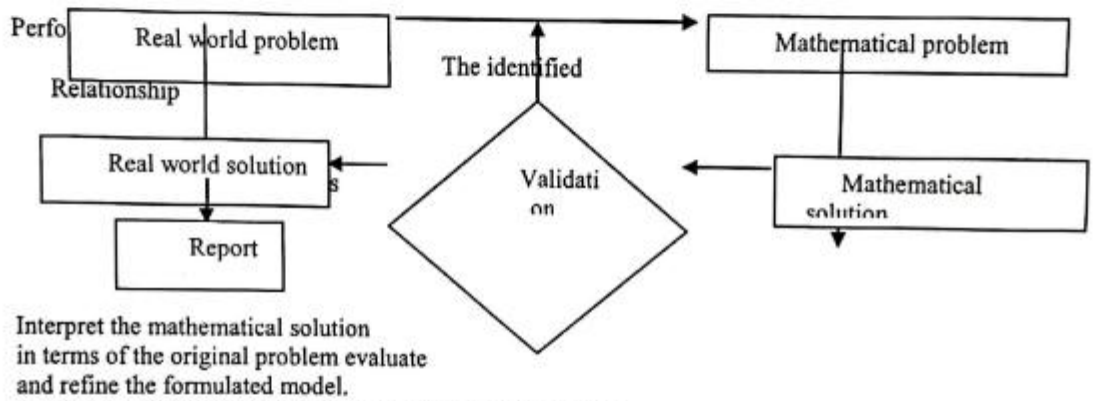
(iii) formulating a model by creating and selecting geometric, graphical, tabular, algebraic or statistical representations that describe relationships between the variables;
(iv) analyzing and performing operations on these relationships to draw conclusions, if the implementation of the performed operations cannot be complete, then revise the selection of the variables used to formulate the models;
(v) interpreting the results of the mathematics in terms of the original situation;
(vi) validating the conclusions by comparing them with the situation and then either improving the model or if it is acceptable; and
(vii) Applying the model to similar situations for evaluation and refinement.

The process of developing sufficiently useful models for a specific purpose usually involves a series of iterative testing and revision cycles. Also choices, assumptions and approximations are present throughout the modeling cycle.

This characterization of the model building is illustrated in figure.



5. PRINCIPLES FOR EFFICIENT MODEL BUILDING

As much as all steps that are taken during a modelling cycle are important, it makes an important difference whether it is a good model or a bad one if a mathematical model is used to improve decisions. The model one has available may not be good enough to use, or there may be more efficient models available for use in a given situation. The forefront of the thinking about mathematical modelling and suggests six principles to go by in taking the measure of a model: Accuracy, descriptive, realism, precision, robustness, generality and fruitfulness.

Definitions of the six principles:
A model is said to be

(i) Accurate, if the output of the model (the answer it gives) is correct or very near to correct.
(ii) Descriptively realistic, if it is based on assumptions which are correct.
(iii) Precise, if its predictions are definite numbers (or other definite kinds of mathematical entities; functions, geometric figure, etc.). By contrast, if a model's prediction is a range of numbers (or a set of functions a set of figures, etc.) the model is imprecise.
(iv) Robust, if it is relatively immune to errors in the input data.
(v) General, if it applies to a wide variety of situations.
(vi) Fruitful, if its conclusions are useful or it inspires or points the way to other models.

6. PROBLEMS OF MODEL BUILDING

Based on the completeness and ambiguity of the information composing a problem, modeling problems can be categorized into three types with third type being the most authentic type as follows:

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1. Problems under this category are already carefully defined so there is little ambiguity about what needs to be done and how to do it. They contain all the information necessary to formulate a model. They either specifically call for a certain procedure to be used or its use is evident on prior instruction or placement of the task. Researchers are expected to search for the needed information that is hidden in the problem, recall the (implicitly or explicitly) called for procedure and carry it out correctly. There is no need to collect additional data to formulate a model.
2. Problems under this type still have little ambiguity about what needs to be done and how to do it. However they do not provide all the information needed to successfully complete the task. Although researchers may be given a direction of what data is needed, they need to devise a meaningful way to gather the needed data and test if the gathered data would produce a reasonable answer.
3. These type problems are comprised of information that is pen-ended, incomplete and/or redundant. There is not a well-rehearsed approach or pathway explicitly suggested by the task. Researchers are expected to analyze the task to find what needs to be done and actively examine tasks constraints that may limit or suggest possible solution strategies and solutions.

7. PROBLEMS OF STOCHASTIC MODEL BUILDING

Following are some important problems of stochastic model building which can be frequently arise in the specification stochastic models:

(a) Selection of Stochastic Model
(b) Mis-specification of Stochastic Model
(c) Variables selection for Stochastic Model

(a) Selection of Stochastic Model:

In general, Stochastic Models may be two types namely,

(i) Nested Stochastic Model: If a stochastic model can be described as a particular case of another stochastic model, then the first model is said to be 'Nested Stochastic Model' within second stochastic Model.

(ii) Non-Nested Stochastic Models: Two stochastic models are known as 'Non- Nested Stochastic Models if stochastic model one cannot be derived as a particular case of another stochastic model.

The various diagnostic tests can be used for the selection of good stochastic models. These diagnostic tests have been available in the literature separately for Nested and Non-Nested Stochastic Models. Some of them are given by:

(i) F-test for Nested statistical models.
(ii) Exhaustive search methods.
(iii) Stepwise, Backward and Forward selection Techniques.
(iv) R^2 or coefficient of multiple Determinations as Model Selection Criterion.
(v) Adjusted R^2 or $\overline{R}^2$ as a Model selection criterion.
(vi) Conditional mean Squared Prediction Error criterion (C_p-Criterion) for Model Selection.
(vii) Amemiya's unconditional MSE criterion.
(viii) Ullah criteria for model selection.
(ix) Stopping Rules for model selection using Mean squared error of prediction.
(x) Cox Modified Likelihood Ratio test for model selection.
(xi) Davidson and Mac Kinnon J- test for model selection.
(xii) Fisher and Mc Aleer JA test for model selection.
(xiii) Davidson, Godfrey and Mac Kinnon omitted variables test for model selection.
(xiv) Wu t- test for Model Selection based on Recursive residuals.
(xv) Cross-validation Technique for linear model selection.
(xvi) Berger and pericchi Intrinsic Bayes Factor of model selection.
(xvii) Akaike Bayesian Information criterion for model selection.
(xviii) Fisher Information criterion for model selection.
(xix) The chow Forecast Test of parameter constancy for model selection.
(xx) The Hansen test of parameter Instability for model selection.
(xxi) CUSUM and CUSUMSQ Residuals Test of constancy for Linear Model Selection.
(xxii) Chow test of structural change for Model Selection.

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(xvii) Regression Diagnostics based on PRESS criterion.
(xviii) Quan Press and Q^2 statistics for selection of regressors.

8.Conclusion

In the above talk a brief discussion on different types of models has been proposed and the concept of stages of model building is extensively discussed.Problems of stochastic model building are presented in a lucid manner and the above literature is highly helpful for young researchers in stochastic modelling

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Research Article

AN INNOVATIVE STUDY ON SUM OF POWERS OF INTEGERS

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Abstract: The generalization of sum of integral powers of first n-natural numbers has been an interesting problem among the researchers in Analytical Number Theory for decades. This research article mainly focuses on the derivation of generalized result of this sum. More explicit formula has been derived in order to get the sum of any arbitrary integral powers of first n-natural numbers. Furthermore by using the fundamental principles of Combinatorics and Linear Algebra an attempt has been made to answer an interesting question namely: Is the sum of integral powers of natural numbers a unique polynomial? As a result it is depicted that this sum always equals a unique polynomial over natural numbers. Moreover some properties of the coefficients of this polynomial are derived.More importantly a recurrence relation which can give the formulas for sum of any positive integral powers of first n-natural numbers has been proposed and it is strongly believed that this recurrence relation is the most significant thing in this entire discussion

Key words: Lower triangular matrix, Full rank, Simultaneous non-homogeneous linear equations, Echelon matrix, Consistency, Rank test

1.Introduction

Formulas of sum of integers were first given in generalizable from in west by Thomas Harrot (1560-1621) of England. At about the same time Johann Faulhaber (1580-1635) of Germany gave formulas for these sums upto the 17th power for higher than anyone before him, but hid did not make clear to generalize them. In this article an attempt has been made to give the generalized result. First the mathematical modeling to the evaluation of Σ where p=1,2,3,... is made as follows.

$$1^2+2^2+3^2+\cdots+n^2=\sum_{r=1}^{n}r^2$$

$$2^2+3^2+\cdots+n^2+(n+1)^2=\sum_{r=1}^{n}(r+1)^2$$

On subtraction $(n+1)^2-1^2=\sum_{r=1}^{n}(r+1)^2-$

$$n^2+2n=\sum_{r=1}^{n}(2r+1)$$

$$n^2+2n=2\sum n+n$$

$$\sum n=\frac{n^2+n}{2}=\frac{1}{2}n^2+\frac{1}{2}n$$

$$1^3+2^3+3^3+\cdots+n^3=\sum_{r=1}^{n}r^3$$

$$2^3+3^3+\cdots+n^3+(n+1)^3=\sum_{r=1}^{n}(r+1)^3$$

On subtraction $n^3+3n^2+3n=\sum_{r=1}^{n}(3r^2+3r+$

$$3\sum n^2+3\sum n=n^3+3n^2+2n$$

$$3\sum n^2+\frac{3}{2}n^2+\frac{3}{2}n=n^3+3n^2+2n$$

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$$3\sum n^2 = n^3 + \frac{3n^2}{2} + \frac{n}{2}$$

$$\sum n^2 = \frac{n^3}{3} + \frac{n^2}{2} + \frac{n}{6}$$

$$1^4 + 2^4 + 3^4 + \cdots + n^4 = \sum_{r=1}^{n} r^4$$

$$2^4 + 3^4 + \cdots + n^4 + (n+1)^4 = \sum_{r=1}^{n} (r+1)^4$$

On subtraction $(n+1)^4 - 1^4 = \sum_{r=1}^{n}(4r^3 + 6r^2 + 4r +$

$$n^4 + 4n^3 + 6n^2 + 4n = 4\sum n^3 + 6\sum n^2 + 4\sum n + \sum 1$$

$$n^4 + 4n^3 + 6n^2 + 4n = 4\sum n^3 + 6\left(\frac{n^3}{3} + \frac{n^2}{2} + \frac{n}{6}\right) + 4\left(\frac{n^2}{2} + \frac{n}{2}\right) + n$$

$$n^4 + 4n^3 + 6n^2 + 4n = 4\sum n^3 + 2n^3 + 3n^2 + n + 2n^2 + 2n + n$$

$$n^4 + 2n^3 + n^2 = 4\sum n^3$$

$$\sum n^3 = \frac{n^4}{4} + \frac{n^3}{2} + \frac{n^2}{2}$$

From the above observations one can assume that Σ is a polynomial of degree p+1 in n over natural numbers and this polynomial is free of constant terms.

2. Existence and Uniqueness of Polynomial

Let $\sum_{m=1}^{n} m^p = 1^p + 2^p + 3^p + \cdots \ldots \ldots \ldots \ldots \ldots + n^p = \Sigma$

$p \in W = \{0,1,2,3 \ldots \ldots\}$

One can make the assumption as follows

Σ is a polynomial of degree p+1 in n over N with no constants

That is

$$\sum_{m=1}^{n} n^p = \sum n^p = k_0 n^{p+1} + k_1 n^p + k_2 n^{p-1} + k_3 n^{k-2} + \cdots + k \quad (1)$$

where $k_0, k_1, k_2, \ldots \ldots \ldots$ are unknown coefficients.

To prove this one can use direct proof in the sense that if $k_0, k_1, k_2, \ldots \ldots \ldots$ exist then the above statement is valid

Now one can have

$$1^p + 2^p + 3^p + \cdots \ldots \ldots \ldots \ldots \ldots + n^p = k_0 n^{p+1} + k_1 n^p + k_2 n^{p-1} + \cdots + k \quad (2)$$

Replacing n by (n+1)

$$1^p + 2^p + 3^p + \cdots \ldots \ldots \ldots \ldots \ldots + n^p + (n+1)^p = k_0(n+1)^{p+1} + k_1(n+1)^p + k_2(n+1)^{p-1} + \cdots + k_p(n+1)$$

Subtracting (2) from (3)

$$(n+1)^p = k_0[(n+1)^{p+1} - n^{p+1}] + k_1[(n+1)^p - n^p] + k_2[(n+1)^{p-1} - n^{p-1}] + \cdots + k_{p-1}[(n+1)^2 - n^2] + k_p[(n+1) - n] \quad (3)$$

$$p_{c_0} n^p + p_{c_1} n^{p-1} + p_{c_2} n^{p-2} + \cdots + p_{c_{p-1}} n + p_{c_p} =$$

$$k_0\left[(p+1)_{c_1} n^p + (p+1)_{c_2} n^{p-1} + \cdots + (p+1)_{c_p} n + (p+1)_{c_{(p+1)}}\right]$$

$$+ k_1\left[p_{c_1} n^{p-1} + p_{c_2} n^{p-2} + \cdots + p_{c_{p-1}} n + p\right.$$

$$+ k_2\left[(p-1)_{c_1} n^{p-2} + (p-1)_{c_2} n^{p-3} + \cdots + (p-1)_{c_{p-2}} n + (p-1)_{c_p}\right.$$

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$$+ \quad k_{p-1}[2_{c_1}n + 2_{c_2}] + k_p[1 \qquad (4)$$

Comparing the coefficients of $n^p, n^{p-1}, n^{p-2}, \ldots\ldots\ldots$, constants

$$p_{c_0} = k_0(p+1)_{c_1}$$
$$p_{c_1} = k_0(p+1)_{c_2} + k_1 p_{c_1}$$
$$p_{c_2} = k_0(p+1)_{c_3} + k_1 p_{c_2} + k_2(p-1)_{c_1}$$
$$p_{c_3} = k_0(p+1)_{c_4} + k_1 p_{c_3} + k_2(p-1)_{c_2} + k_3(p-2)_{c_1}$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$p_{c_{p-1}} = k_0(p+1)_{c_p} + k_1 p_{c_{p-1}} + k_2(p-1)_{c_{(p-2)}} + \cdots + k_{p-1}2_{c_1}$$
$$p_{c_p} = k_0(p+1)_{c_{(p+1)}} + k_1 p_{c_p} + k_2(p-1)_{c_{(p-1)}} + \cdots + k_p 1_{c_1}$$

These are (p+1) simultaneous non homogeneous linear equations in (p+1) unknowns $k_0, k_1, \ldots$.

From the last one it is obvious that $k_0 + k_1 + k_2 + \cdots + k_p =$

From the first one, one can get $k_0 =$

Writing the above system in matrix notation

$$\begin{bmatrix} (p+1)_{c_1} & 0 & 0 & \ldots & 0 \\ (p+1)_{c_2} & p_{c_1} & 0 & \ldots & 0 \\ (p+1)_{c_3} & p_{c_2} & (p-1)_{c_1} & \ldots & 0 \\ \cdot & \cdot & \cdot & \ldots & \cdot \\ (p+1)_{c_{p+1}} & p_{c_p} & (p-1)_{c_{p-1}} & \ldots & 1_{c_1} \end{bmatrix} \begin{bmatrix} k_0 \\ k_1 \\ k_2 \\ \cdot \\ kp \end{bmatrix} = \begin{bmatrix} p_{c_0} \\ p_{c_1} \\ p_{c_2} \\ \cdot \\ p_{c_p} \end{bmatrix}$$

$$MX = N$$

$$M = \begin{bmatrix} (p+1)_{c_1} & 0 & 0 & \ldots & 0 \\ (p+1)_{c_2} & p_{c_1} & 0 & \ldots & 0 \\ (p+1)_{c_3} & p_{c_2} & (p-1)_{c_1} & \ldots & 0 \\ \cdot & \cdot & \cdot & \ldots & \cdot \\ (p+1)_{c_{p+1}} & p_{c_p} & (p-1)_{c_{p-1}} & \ldots & 1_{c_1} \end{bmatrix}$$

Here

$$X = \begin{bmatrix} k_0 \\ k_1 \\ k_2 \\ \cdot \\ kp \end{bmatrix}, \text{a column vector}$$

$$N = \begin{bmatrix} p_{c_0} \\ p_{c_1} \\ p_{c_2} \\ \cdot \\ p_{c_p} \end{bmatrix}, \text{a column vector}$$

M is of full rank and $\rho(M) = p +$

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M is lower triangular matrix.

$|M| = (p+1)! \neq 0$

Now the consistency of this system is to be examined through rank test

Number of unknowns = p+1 = Number of equations

$$M \sim \begin{bmatrix} (p+1)_{c_{p+1}} & p_{c_p} & (p-1)_{c_{p-1}} & \cdots & 2_{c_2} & 1_{c_1} \\ (p+1)_{c_p} & p_{c_{p-1}} & (p-1)_{c_{p-2}} & \cdots & 2_{c_1} & 0 \\ \cdot & \cdot & \cdot & \cdots & \cdot & \cdot \\ (p+1)_{c_3} & p_{c_2} & (p-1)_{c_1} & \cdots & 0 & 0 \\ (p+1)_{c_2} & p_{c_1} & 0 & \cdots & 0 & 0 \\ (p+1)_{c_1} & 0 & 0 & \cdots & 0 & 0 \end{bmatrix}$$

M is an Echelon matrix

Number of non-zero rows in $M = p+1 = \rho($.

$$M \sim \begin{bmatrix} (p+1)_{c_{p+1}} & p_{c_p} & (p-1)_{c_{p-1}} & \cdots & 2_{c_2} & 1_{c_1} & p_{c_0} \\ (p+1)_{c_p} & p_{c_{p-1}} & (p-1)_{c_{p-2}} & \cdots & 2_{c_1} & 0 & p_{c_{p-1}} \\ \cdot & \cdot & \cdot & \cdots & \cdot & \cdot & \cdot \\ (p+1)_{c_3} & p_{c_2} & (p-1)_{c_1} & \cdots & 0 & 0 & p_{c_2} \\ (p+1)_{c_2} & p_{c_1} & 0 & \cdots & 0 & 0 & p_{c_1} \\ (p+1)_{c_1} & 0 & 0 & \cdots & 0 & 0 & p_{c_0} \end{bmatrix}$$

$\rho([M\ N]) = p+1$

Since $\rho(M) = \rho([M\ N]) = p+$ the system is consistent.

Further common rank = number of unknowns

Hence the above system possesses unique solution.

Consequently $k_0, k_1, \cdots$ exist uniquely.

3. Computing the coefficients

From the above matrix system one can get

$(p+1)_{c_1} k_0 = p_{c_0}$

$k_0 = \frac{1}{p+1}$

$(p+1)_{c_2} k_0 + p_{c_1} k_1 = p_{c_1}$

$\frac{(p+1)\,p}{1.2}\frac{1}{p+1} + p\,k_1 = p$

$k_1 = \frac{1}{2}$

$(p+1)_{c_3} k_0 + p_{c_2} k_1 + (p-1)_{c_1} k_2 = p_{c_2}$

$\frac{(p+1)\,p\,(p-1)}{1.2.3}\frac{1}{p+1} + \frac{p\,(p-1)}{1.2}\frac{1}{2} + (p-1)k_2 = \frac{p\,(p-1)}{2}$

$\frac{p}{6} + \frac{p}{4} + k_2 = \frac{p}{2}$

$k_2 = \frac{p}{12}$

$(p+1)_{c_4} k_0 + p_{c_3} k_1 + (p-1)_{c_2} k_2 + (p-2)_{c_1} k_3 = p_{c_3}$

$$\frac{(p+1)\,p\,(p-1)(p-2)}{1.2.3.4}\frac{1}{p+1}+\frac{p\,(p-1)(p-2)}{1.2.3}\frac{1}{2}+\frac{(p-1)(p-2)}{1.2}\frac{p}{12}+(p-2)k_3$$
$$=\frac{p\,(p-1)(p-2)}{1.2.3}$$
$$\frac{p\,(p-1)}{24}+\frac{p\,(p-1)}{12}+\frac{p\,(p-1)}{24}+k_3=\frac{p\,(p-1)}{6}$$
$$k_3=0$$
$$(p+1)_{c_5}\,k_0+p_{c_4}k_1+(p-1)_{c_3}k_2+(p-2)_{c_2}k_3+(p-3)_{c_1}k_4=p_{c_4}$$
$$\frac{(p+1)\,p\,(p-1)(p-2)(p-3)}{1.2.3.4.5}\frac{1}{p+1}+\frac{p\,(p-1)(p-2)(p-3)}{1.2.3.4}\frac{1}{2}+$$
$$\frac{(p-1)(p-2)(p-3)}{1.2.3}\frac{p}{12}+\frac{(p-2)(p-3)}{1.2}0+(p-3)k_4=\frac{p\,(p-1)(p-2)(p-3)}{1.2.3.4}$$
$$\frac{p\,(p-1)(p-2)}{120}+\frac{p\,(p-1)(p-2)}{48}+\frac{p\,(p-1)(p-2)}{72}+k_4=\frac{p\,(p-1)(p-2)}{24}$$
$$k_4=p(p-1)(p-2)\left(\frac{1}{24}-\frac{1}{72}-\frac{1}{120}-\frac{1}{48}\right)$$
$$k_4=\frac{-p\,(p-1)(p-2)}{720}$$

In this manner on can get $k_5, k_6, k_7 \ldots$

It is interesting to observe that is a polynomial of degree r-1 in p where r=0,1,2,3,...

4. Applications of coefficients

$$\sum_{m=1}^{n} m^p = k_0 n^{p+1}+k_1 n^p+k_2 n^{p-1}+k_3 n^{p-2}+\cdots+k_p n$$

$For\ p=1,\quad k_0=\frac{1}{p+1}=\frac{1}{2}$

$$k_1=\frac{1}{2}$$

So, $\sum_{m=1}^{n} m^p=\sum n=1+2+3+\cdots\ldots\ldots\ldots+n=\frac{1}{2}n^2+$

For p=2 $k_0=\frac{1}{p+1}$:

$$k_1=\frac{1}{2}$$
$$k_2=\frac{p}{12}=\frac{2}{12}=\frac{1}{6}$$

So, $\sum_{m=1}^{n} m^p=\sum n^2=1^2+2^2+3^2+\cdots\ldots\ldots\ldots+n^2=\frac{1}{3}n^3+\frac{1}{2}n^2+$

For p=3. $k_0=\frac{1}{p+1}$:

$$k_1=\frac{1}{2}$$
$$k_2=\frac{p}{12}=\frac{3}{12}=\frac{1}{4}$$
$$k_3=0$$

So, $\sum_{m=1}^{n} m^p=\sum n^3=1^3+2^3+3^3+\cdots\ldots\ldots\ldots+n^3=\frac{1}{4}n^4+\frac{1}{2}n^3+\frac{1}{4}$

For p=4

$$k_0=\frac{1}{p+1}=\frac{1}{5}$$

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$$k_1 = \frac{1}{2}$$
$$k_2 = \frac{p}{12} = \frac{4}{12} = \frac{1}{3}$$
$$k_3 = 0$$
$$k_4 = \frac{-p\,(p-1)(p-2)}{720} = \frac{-4.3.2}{720} = -\frac{1}{30}$$

So, $\sum_{m=1}^{n} m^p = \sum n^4 = 1^4 + 2^4 + 3^4 + \cdots \ldots \ldots \ldots + n^4 = \frac{1}{5}n^5 + \frac{1}{2}n^4 + \frac{1}{3}n^3 - \frac{1}{3}$

Proceeding in this manner one can get $\sum n^5, \sum n^6, \sum n^7, \ldots ..$

All constants can be computed from the recurrence relation given by

$$(p+1)_{c_{(i+1)}} k_0 + p_{c_i} k_1 + (p-1)_{c_{(i-1)}} k_2 + \cdots + (p-i+1)_{c_i} k_i = p_{c_i}$$

$$i = 0,1,2$$

By substituting i=0,1,2,3..... one can find k_0, k_1, k_2

5. Crammer's rule in the evaluation of constants

The constants of the unique polynomial namely $k_0, k_1, k_2 \ldots$ can be found by Crammer's rule as shown below.

$$\Delta = |M| = (p+1)! \neq 0$$

$$\Delta_1 = \begin{vmatrix} p_{c_0} & 0 & 0 & \ldots & 0 & 0 \\ p_{c_1} & p_{c_1} & 0 & \ldots & 0 & 0 \\ p_{c_2} & p_{c_2} & (p-1)_{c_1} & \ldots & 0 & 0 \\ . & . & . & \ldots & . & . \\ p_{c_{p-1}} & p_{c_{p-1}} & (p-1)_{c_{p-2}} & \ldots & 2_{c_1} & 0 \\ p_{c_p} & p_{c_p} & (p-1)_{c_{p-1}} & \ldots & 2_{c_2} & 1_{c_1} \end{vmatrix}$$

Δ_1 =The determinant obtained by replacing the first column of $|$ by column vector N

Δ_2 = The determinant obtained by replacing the second column of $|$ by column vector N

.....

Δ_{p+1} = The determinant obtained by replacing the $(p+1)^{th}$ column of $|$ by column vector N

$$k_0 = \frac{\Delta_1}{\Delta};\ k_1 = \frac{\Delta_2}{\Delta};\ \ldots \ldots \ldots \ldots\ k_p = \frac{\Delta_{p+1}}{\Delta}$$

6. Conclusions and Future Research

In the above discussion a generalized result for sum of any arbitrary positive integral powers of first n-natural numbers has been derived by using the fundamentalconcepts in Combinatorics and Linear Algebra.Most importantly the above conversation hs given answers to two interesting questions in the research field of Analytic Number Theory.They are:Is the sum of integral powers of natural numbers always a polynomial?and Is such polynomial unique?.The most significant thing in this article is the recurrence relation given by fifth equation which will enable us to write the formulas for the sum of any positive integral powers of first n- natural numbers in terms of n.In the context of future research one can derive some more generalized results by using the Bernoulli's polynomial and some fundamental principles in Real and Complex Analyses.

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Problems Encountered by the Women Entrepreneurs of MSMEs in SPSR Nellore District

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Abstract-Women entrepreneurship has been recognized as one of the important foundations for the economic progress. Women entrepreneurs are creating the new jobs for themselves and also for others and provide different solutions to the management, organisation and business problems. Women entrepreneurs are the women who initiate a business, gather all resources, take risks, face challenges, provide employment to others and manage the business independently. The importance of female entrepreneurship for economic development is widely recognized. Women entrepreneurs are in the minority and they have to face many obstacles on their journey. Women entrepreneurs often face gender-based barriers to starting and growing their businesses, like discriminatory property, matrimonial and inheritance laws and/or cultural practices; lack of access to formal finance mechanisms; limited mobility and access to information and networks, etc. Besides, the women entrepreneurs are facing difficulties while getting loans, Problem of Raw material, Problem with Competition, Marketing problems, Problem of Finance and Problem of Labour in the study area. In this paper, an attempt is made to find out the problems of women entrepreneurs of MSMEs in Nellore District.

Keywords: Women Entrepreneurs, Entrepreneurship, MSMEs (Micro, Small and Medium Enterprises).

INTRODUCTION

In a developing country like India, the role and importance of Micro, Small, and Medium Enterprises are very significant towards poverty eradication, employment generation, rural development and creating regional balances in the promotion and growth of various development activities. It is necessary to utilize the given resources to the optimum extent to ensure better standards of living for the people and to attain sustained growth in any economy. Women entrepreneurship has been recognized as an important source of economic growth. Women entrepreneurs create new jobs for themselves and others and also provide to society with different solutions to management, organisation and business problems. Women entrepreneurs often face gender-based barriers to starting and growing their businesses, like discriminatory property, matrimonial and inheritance laws and/or cultural practices, lack of access to formal finance mechanisms; limited mobility and access to information and networks, etc.

Women entrepreneurs are the women who initiate a business, gather all resources, take risks, face challenges, provide employment to others and manage the business independently. The importance of female entrepreneurship for economic development is widely recognized. Women entrepreneurs are in the minority and they have to face many obstacles on their journey.

REVIEW OF LITERATURE

Sharma K. L. (2018) in his book Entrepreneurial Performance in Role Perspective investigated the rising example of growth of entrepreneurs, their performance and problems. Against the foundation of government help with different structures, entrepreneurs and their problems call for sincere consideration, for the solid and supported financial growth of Indian society. The examination was directed to handle some hypothetical and methodological issues worried about the investigation of the entrepreneurial job of similarity and to toss light on some connected parts of entrepreneurial growth in the territory of Uttar Pradesh. The investigation exposed the absence of reaction of entrepreneurs to the offices made accessible by the government. One may get a kick out of the chance to investigate its reasons, which might be recognized as the insufficiency of entrepreneurs, the lacking terms and states of the offices, the ineffectualness of the foundations giving the offices, and the inefficiency of the personnel employed in it.

Prasanthi Goyal (2019) in her study, the increasing presence of women as entrepreneurs has led to the change in the demographic characteristics of business and economic growth of the country. Women-owned businesses enterprises are playing a prominent role in society inspiring others and generating more

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employment opportunities in the country. There is a need for sustainable growth of women entrepreneurs, to promote a balanced growth in the country and Start-ups. India is committed to strengthening the women entrepreneurship ecosystem through policies and initiatives and creation of enabling networks.

Narendranath Singh (2020) in his study World over one-third of the entrepreneurial ventures is run by women entrepreneurs. Due to economic progress, better access to education, urbanization, spread of liberal and democratic cultures and recognition by society, there has been a spurt in woman entrepreneurship in India. Special incentives and drives have been created in India to bolster the growth of women entrepreneurs. Schemes like Startups India and Standup also make special case to promote entrepreneurial drive among women. Gradually but steadily, world over, women entrepreneurs have emerged as successful entrepreneurs while earning many accolades for themselves.

Vital Chandra (2021) Development of Women Entrepreneurship in India-An investigation of public and projects uncovers that financial factors are influencing the women entrepreneurs. The discoveries about financial factors influencing the women entrepreneurs are as under (1) As far as the time of women entrepreneurs is concerned, larger part of the entrepreneurs is young and have all the power and time to seek after their dare to see them completely grown. (2) Majority of women did not have a place with business families. They were young entrepreneurs who took the challenge without anyone else activity and inspiration. (3) Marital status or family ties in greater part of the cases did not meddle essentially in proceeding with the endeavour (4) About 60 percent entrepreneurs had experienced some training before beginning their undertaking (5) Religion astute appropriation demonstrated lion's share having a place with Hindu religion. (6) Majority of the entrepreneurs did not have any involvement in any business adventures before beginning their own business.

OBJECTIVES OF THE STUDY

The main objective of this paper is to study the problems encountered by the women entrepreneurs of MSMEs in SPSR Nellore district.

SAMPLING

Primary data is collected from the selected Women Entrepreneurs of MSMEs in SPSR Nellore district from three administrative revenue divisions, Viz. Nellore, Gudur and Kavali. A random sample of 10 per cent of total 4012 Women Entrepreneurs in the district is chosen equals to 400 units (rounded off) covering all categories of Women Entrepreneurs units belonging to different groups and different product lines in MSMEs. In selecting the sample enterprises, the researcher is adopted "Stratified Random Sampling without Replacement".

Sector-wise problems encountered by the Women Entrepreneurs of MSMEs

Table 1 reveals that the sector wise problems faced while getting loan by women entrepreneurs of MSMEs in SPSR Nellore District. It can be seen from the table in micro enterprises, while getting loan by women entrepreneur problem faces by security reason were 32 (18.50 percent), bank employee was 36 (20.81 percent), by group members were 50 (28.90 percent) and by government regulations were 55 (31.79 percent) out of 173 sample women entrepreneurs.

Table 1-Problems encountered by Women Entrepreneurs while getting loans in the District

S. No	Face problem while getting loan to Women Entrepreneurs	Micro Enterprise	Small Enterprise	Medium Enterprise	Total
1	Security reason	32 (18.50)	27 (21.43)	21 (20.79)	80 (20.00)
2	Bank employee	36 (20.81)	33 (26.19)	26 (25.74)	95 (23.75)
3	By Group members	50 (28.90)	36 (28.57)	24 (23.76)	110 (27.50)
4	By Government regulations	55 (31.79)	30 (23.81)	30 (29.70)	115 (28.75)
Total		173 (100)	126 (100)	101 (100)	400 (100)
X^2 Value = 1.5276, Sig at 5 percent Level 15.507					

Note: Figures in parenthesis represent the percentages
Source: Field Survey

In small enterprises, while getting loan by women entrepreneur problem faces by security reason were 27 (21.43 percent), bank employee was 33 (26.19 percent), by group members were 36 (28.57 percent), and by government regulations were 30 (23.81 percent) out of 126. In medium enterprises, while

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getting loan by women entrepreneur problem faces with security reason were 21 (20.79 percent), bank employee was 26 (25.74 percent), by group members were 24 (23.76 percent) and by government regulations were 30 (29.79 percent) out of 101.

In the Chi-Square results, table value of Chi-Square at 5 percent level of significance for 8 degree of freedom is 15.507. Calculated value is 1.5276. Calculated value is less than the table value, it can be accepted the null hypothesis. It may be concluded that there is goodness of fit. There is significance in problems encountered while getting loans by women entrepreneurs of MSMEs.

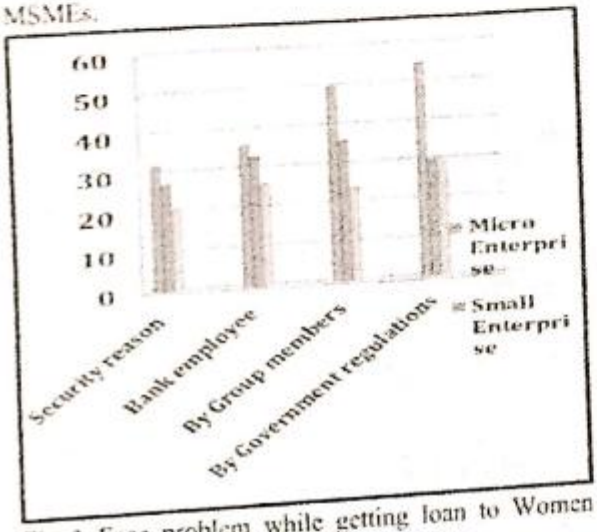

Fig 1 Face problem while getting loan to Women Entrepreneurs of MSMEs

Sector-wise Problem of Raw material of Women entrepreneurs of MSMEs

Table 2 describes the sector wise problem of raw material of women entrepreneurs of MSMEs in SPSR Nellore District. Women entrepreneurs are problem facing with raw material i.e., not available in required quantity, high price and not good quality. In micro enterprises, not available in required quantity was 52 (30.06 percent), high price was 65 (37.57 percent) and not good quality 56 (32.37 percent) out of 173 sample entrepreneurs. In small enterprises, not available in required quantity was 52 (41.27 percent), high price was 44 (34.92 percent) and not good quality 30 (23.81 percent) out of 126 sample entrepreneurs. In medium enterprises, not available in required quantity was 41 (40.59 percent), high price was 25 (24.75 percent) and not good quality 35 (34.65 percent) out of 101 sample entrepreneurs. The women entrepreneurs face the majority problem with not available in required quantity.

Table 2-Sector-wise Problem of Raw material encountered by Women entrepreneurs of MSMEs in SPSR Nellore District

S. No	Problem of Raw material	Micro Enterprise	Small Enterprise	Medium Enterprise	Total
1	Not available in required quantity	52 (30.06)	52 (41.27)	41 (40.59)	145 (36.25)
2	High price	65 (37.57)	44 (34.92)	25 (24.75)	134 (33.50)
3	Not good quality	56 (32.37)	30 (23.81)	35 (34.65)	121 (30.25)
Total		173 (100)	126 (100)	101 (100)	400 (100)

Note: Figures in parenthesis represent the percentages

Source: Field Survey

Data taken from the Table 2, the ANOVA results' calculated value of F is 5.7190. Table value of F at 5 per cent level of significance for 2.6 degree of freedom is 5.1433. As the calculated value is more than the table value, rejected the null hypothesis. It can terminate that there is a significant difference in the sector wise problem of raw material faced by women entrepreneurs of MSMEs.

Variation	Sum of Square	Degree of Freedom	Mean Square	F-Value	P-value	Table value
V1	890.8589	2	445.4444	5.7190	0.0407	5.1433
V2	467.3333	6	77.8889			
Total	1358.222	8				

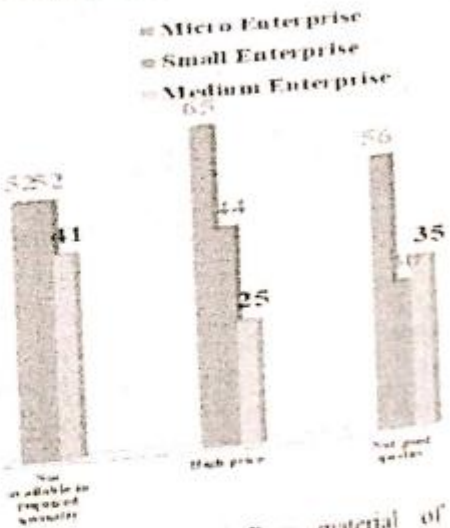

Fig 2 Problem of Raw material of Women entrepreneurs of MSMEs

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Sector-wise Problem of Competition encountered by women entrepreneurs

Table 3 exhibits that the sector wise women entrepreneurs faced the problem of competition by women entrepreneurs of MSMEs in SPSR Nellore District. Out of 173 micro enterprises, competition from large units IMNCs were 55 (31.79 percent), competition from imported substitutes were 50 (28.90 percent), established small scale units in other regions were 36 (20.81 percent) and, well-established small-scale units in the region were 32 (18.50 percent). Out of 126 sample entrepreneurs, competition from large units IMNCs were 30 (23.81 percent), competition from imported substitutes were 36 (28.57 percent), established small scale units in other regions were 33 (26.19 percent), and well-established small-scale units in the region were 27 (21.43 percent). Out of 101 sample entrepreneurs, competition from large units IMNCs were 30 (29.70 percent), competition from imported substitutes were 21 (20.79 percent), established small scale units in other regions were 26 (25.74 percent and well-established small-scale units in the region were 24 (23.76 percent).

Table 3 Sector-wise Problem of Competition encountered by the women entrepreneurs of MSMEs in SPSR Nellore District

S. No.	Problem with Competition	Micro Enterprises	Small Enterprises	Medium Enterprises	Total
1	Competition from large units IMNCs	55 (31.79)	30 (23.81)	30 (29.70)	115 (28.75)
2	Well-established small scale units in the region	50 (28.90)	36 (28.57)	24 (23.76)	110 (27.50)
3	Established small scale units in other regions	36 (20.81)	33 (26.19)	26 (25.74)	95 (23.75)
4	Competition from imported substitutes	32 (18.50)	27 (21.43)	21 (20.79)	80 (20.00)
	Total	173 (100)	126 (100)	101 (100)	400 (100)

Note: Figures in parenthesis represent the percentages

Source: Field Survey

As from the Table 3, the ANOVA results' calculated value of F is 6.6743. Table value of F at 5 percent level of significance for 2,9 degree of freedom is 4.2565. As the calculated value is bigger than the table value, we reject the null hypothesis. It can finish that there is significant difference in problem with competition of the Women Entrepreneurs of MSMEs

ANOVA

Variation	Sum of Square	Degree of Freedom	Means Square	F value	P value	Table value
V1	668.1667	2	334.0831	6.6743	0.016	4.2565
V2	450.5	9	50.0556			
Total	1118.667	11				

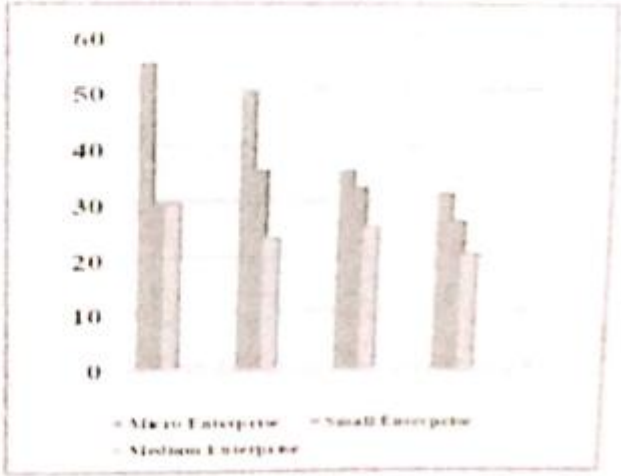

Fig 3 Problem with Competition women entrepreneurs of MSMEs

Sector-wise Marketing Problems Encountered by Women Entrepreneurs of MSMEs

Table 4 reveals that the sector-wise marketing problems faced by women entrepreneurs of MSMEs in SPSR Nellore District. There are so many marketing problems faced by the MSME women entrepreneurs i.e., Competitors reaction, In-efficient sales force, High cost of marketing, Inadequate sales promotion, Customer resistance, Inferior quality, Ineffective after sales service, improper distribution strategy, untimely introduction of product, Governmental regulations, like levy and High cost of advertisement.

Out of 173 micro enterprises, faced by the marketing problems, competitors reaction was 22 (12.72 percent), inefficient sales force and high cost of marketing and ineffective after sales service was 20 (11.56 percent), inadequate sales promotion was 19 (10.98 percent), customer resistance was 11 (6.36 percent), untimely introduction of product was 10 (5.78 percent), inferior quality was 16 (9.25 percent), improper distribution strategy was 13 (7.51 percent), Governmental regulations was 12 (6.94 percent), and

High cost of advertisement was 10 (5.78 percent). Out of 100 sample entrepreneurs in Small Enterprises, faced by the competitors reaction was 15 (11.91 percent), insufficient sales force was 18 (14.29 percent), high cost of marketing was 15 (11.91 percent), inadequate sales promotions was 13 (10.32 percent), customer resistance was 12 (9.52 percent), inferior quality was 11 (8.73 percent), Ineffective after sales service was 10 (7.94 percent), improper distribution strategy and Governmental regulations was 9 (7.14 percent), untimely introduction of product was 10 (7.94 percent), and High cost of advertisement was 4 (3.18 percent). Out of 100 sample entrepreneurs in Medium enterprises, faced by the competitors reaction was 12 (11.88 percent), insufficient sales force was 13 (12.87 percent), high cost of marketing was 12 (11.88 percent), inadequate sales promotions was 11 (10.89 percent), customer resistance was 10 (9.90 percent), inferior quality and Ineffective after sales service was 9 (8.91 percent), improper distribution strategy was 7 (6.93 percent), Governmental regulations was 8 (7.92 percent), and High cost of advertisement was 4 (3.96 percent).

Table 4-Sector-wise Marketing problems encountered by women entrepreneurs of MSMEs

S. No	Marketing problems	Micro Enterprise	Small Enterprise	Medium Enterprise	Total
1	Competitors reaction	22 (12.72)	15 (11.91)	12 (11.88)	49 (12.25)
2	In-efficient sales force	20 (11.56)	18 (14.29)	13 (12.87)	51 (12.75)
3	High cost of marketing	20 (11.56)	15 (11.91)	12 (11.88)	47 (11.75)
4	Inadequate sales promotion	19 (10.98)	13 (10.32)	11 (10.89)	43 (10.75)
5	Customer resistance	11 (6.36)	12 (9.52)	10 (9.90)	33 (8.25)
6	Inferior quality	16 (9.25)	11 (8.73)	9 (8.91)	36 (9.00)
7	Ineffective after sales service	20 (11.56)	10 (7.94)	9 (8.91)	39 (9.75)
8	Improper distribution strategy	13 (7.51)	9 (7.14)	7 (6.93)	29 (7.25)
9	Untimely introduction of product	10 (5.78)	10 (7.94)	6 (5.94)	26 (6.50)
10	Governmental regulations, like levy Etc	12 (6.94)	9 (7.14)	8 (7.92)	29 (7.25)
11	High cost of advertisement	10 (5.78)	4 (3.18)	4 (3.96)	18 (4.50)
Total		173 (100)	126 (100)	101 (100)	400 (100)

Note: Figures in parenthesis represent the percentages
Source: Field Survey

Data taken from the table 4, to analyse the ANOVA results, calculated value of F is 8.3870. Table value of F at 5 percent level of significance for 2,3 degree of freedom is 3.3158. As the calculated value is bigger than the table value, we reject the null hypothesis. It can close that there is significant difference in sector-wise marketing problems women entrepreneurs of MSMEs.

Varnation	Sum of Square	Degree of freedom	Means Square	F-Value	P-value	Table value
V1	242.9697	2	121.4848	8.3870	0.0013	3.3158
V2	434.5455	30	14.4848			
Total	677.5152	32				

Sector-wise Problem of Finance encountered by women entrepreneurs of MSMEs

Table 5 shows that the sector wise problem of finance faced by the women entrepreneurs of MSMEs in SPSR Nellore District. In micro enterprises that there are so many finance problems faced by the women entrepreneurs like Shortage of fixed Capital and Shortage of Working Capital was 42 (24.28 percent), Increase in product Cost was 35 (20.23 percent), Delays in realization of bills was 34 (19.65 percent) and Un-favourable trade terms was 20 (11.56 percent) out of 173 sample enterprises.

In small enterprises, Shortage of fixed Capital was 33 (26.19 percent), Shortage of Working Capital 30 (23.81 percent), Increase in product Cost was 24 (19.05 percent), Delays in realization of bills was 21 (16.67 percent) and Un-favourable trade terms was 18 (14.29 percent) out of 126 sample enterprises.

In Medium enterprises, Shortage of fixed Capital was 26 (25.74 percent), Shortage of Working Capital 24 (23.761 percent), Increase in product Cost was 21 (20.79 percent), Delays in realization of bills was 16 (15.84 percent) and Un-favourable trade terms was 14 (13.86 percent) out of 101 sample enterprises.

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Table 5-Sector-wise Problem of Finance faced by women entrepreneurs of MSMEs

S No	Problem of Finance	Micro Enterprise	Small Enterprise	Medium Enterprise	Total
1	Shortage of fixed Capital	42 (24.28)	33 (26.19)	26 (25.74)	101 (25.25)
2	Shortage of Working Capital	42 (24.28)	30 (23.81)	24 (23.76)	96 (24.00)
3	Increase in product Cost	35 (20.23)	24 (19.05)	21 (20.79)	80 (20.00)
4	Delays in realisation of bills	34 (19.65)	21 (16.67)	16 (15.84)	71 (17.75)
5	Un-favourable trade terms	20 (11.56)	18 (14.29)	14 (13.86)	52 (13.00)
Total		173 (100)	126 (100)	101 (100)	400 (100)

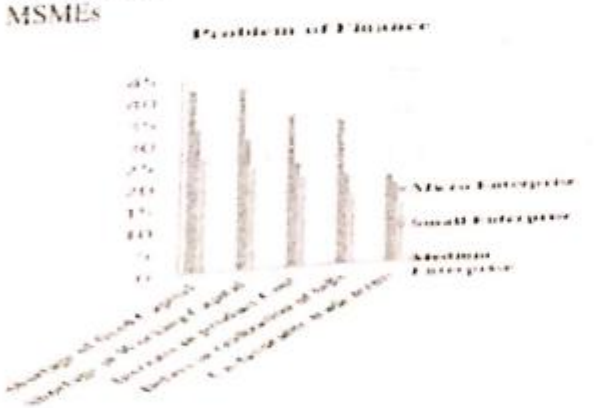
Note: Figures in parenthesis represent the percentages
Source: Field Survey

From the table 5 to analyse the ANOVA results calculated value of F is 4.4966. Table value of F at 5 percent level of significance for 2,12 degree of freedom is 3.8853. As the calculated value is greater than the table value, we reject the null hypothesis. It can conclude that there is significant difference in sector wise problem of finance faced by the women entrepreneurs of MSMEs.

ANOVA:

Variation	Sum of Square	Degree of freedom	Mean Square	F-Value	P-value	Table value
V1	488.9333	2	244.4667	4.4966	0.0349	3.8853
V2	652.4000	12	54.3667			
Total	1141.3333	14				

Fig 4 Problem of Finance to women entrepreneurs of MSMEs



Sector-wise Problem of Labour faced by the Women entrepreneurs of MSMEs

Sector-wise Problem of Labour faced by Women entrepreneurs of MSMEs in SPSR Nellore District presented in Table 6. Out of 173 micro enterprises, many labour problems faced by the women entrepreneurs similar to; non-availability of skilled labour was 42 (24.28 percent), non-availability of casual labour was 45 (26.01 percent). Demand for high wages was 36 (20.81 percent). Low productivity / Low efficiency was 28 (16.18 percent) and Absenteeism was 22 (12.72 percent).

Table 6-Sector-wise Problem of Labour encountered by Women entrepreneurs of MSMEs in SPSR Nellore District

S.No	Problem of Labour	Micro Enterprise	Small Enterprise	Medium Enterprise	Total
1	Non-availability of skilled labour	42 (24.28)	32 (25.40)	26 (25.74)	100 (25.00)
2	Non-availability of casual labour	45 (26.01)	26 (20.63)	19 (18.81)	90 (22.50)
3	Demand for high wages	36 (20.81)	24 (19.05)	22 (21.78)	82 (20.50)
4	Low productivity / Low efficiency	28 (16.18)	21 (16.67)	19 (18.81)	68 (17.00)
5	Absenteeism	22 (12.72)	23 (18.25)	15 (14.85)	60 (15.00)
Total		173 (100)	126 (100)	101 (100)	400 (100)

Note: Figures in parenthesis represent the percentages
Source: Field Survey

Out of 126 small enterprises, non-availability of skilled labour was 32 (25.40 percent), non-availability of casual labour was 26 (20.63 percent). Demand for high wages was 24 (19.05 percent). Low productivity / Low efficiency was 21 (16.67 percent) and Absenteeism was 23 (18.25 percent). Out of 101 medium enterprises, non-availability of skilled labour was 26 (25.74 percent), non-availability of casual labour and Low productivity / Low efficiency was 19 (18.81 percent). Demand for high wages was 22 (21.78 percent), and Absenteeism was 15 (14.85 percent). Eventually, a majority labour problem faced by the women entrepreneurs' non-availability of skilled labour with 100 (25 percent).

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From the table 6, to analyse the ANOVA results calculated value of F is 6.3534. Table value of F at 5 percent level of significance for (2,12) degree of freedom is 3.8853. As the calculated value is larger than the table value, we reject the null hypothesis. It can conclude that there is significant difference in Problem of Labour of Women entrepreneurs of MSMEs.

ANOVA

Variation	Sum of Squares	Degree of Freedom	Mean Square	F-value	P-value	Table value
V1	534.5333	2	267.26 67			
V2	504.8	12	42.066 7	6.3 534	0.0 13 1	3.885 3
Total	1039.333	14				

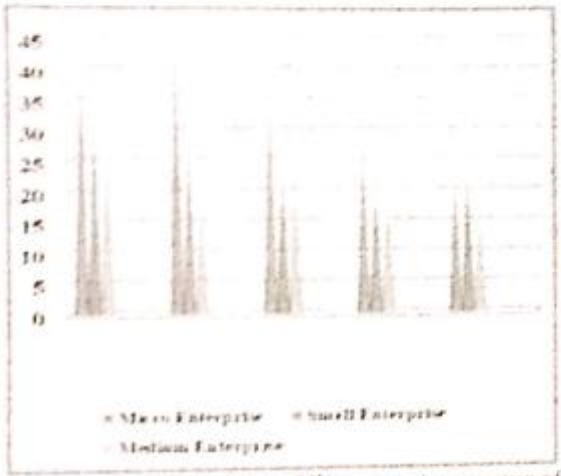

Fig 5 Problem of Labour of Women entrepreneurs of MSMEs

CONCLUSION

It is concluded that the Women from various classes and societal backgrounds are now welcomed with open arms in the MSME sector, which once overflowed with businessmen. In India, the introduction of several government incentives for women entrepreneurs has prompted more women to step forward. Both state and central government programs are included. The MSMEs in India are facing a tough situation due to extreme competition from large industries. Though Globalization has increased competitiveness in Indian women entrepreneurs of MSMEs to certain extent, Indian women entrepreneurs of MSMEs are not adequately prepared to compete with the global players. There has been a definite change in attitude of the Government from protection to promotion of the women entrepreneurs of MSMEs. The Govt. has taken several policy initiatives but needs to ensure proper co-ordination and implementation of such schemes. The women entrepreneurs of MSMEs must convert the threats of globalization into opportunities through increased productivity, product diversification, supply chain management, Research and Development activities. It is suggested that, the government and the district authorities should take measures to reduce all the above problems through providing skill development programmes and technical support through advisors to women entrepreneurs in the study area.

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OPERATIONAL PROBLEMS OF HANDLOOM WEAVERS IN SPSR NELLORE DISTRICT

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ABSTRACT

The outstanding history of handloom industry in India as well as of the Nellore district, particularly 'Venkatagiri and Patur sarees', of Andhra Pradesh is well known to all. The handloom industry has also gained fame and name in respect of its usefulness and uniqueness. It is such a sector that provides a huge number of jobs, next to agriculture in India. The handloom industry, which was a symbol of freedom during the independence struggle, it is now well-known for its problems such as competition with the power looms,lack of proper marketing facilities, raw-materials crisis, high labour costs, sharp decline in the number of weavers, lethargy of the new generation in adopting weaving as a livelihood, a number of challenges due to low adaptability in changing trends, lack of skilled manpower, high cost of credit, and so on. So, the government should take the necessary steps to overcome these problems for the development of the handloom industry.

Keywords: Handloom industry, Cooperative weavers, profitability, pre-loan issues,ill-health problems,

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.INTRODUCTION

The handloom industry plays a very important role in the country's economic development. It is one of the largest economic activity, providing direct employment to over 65 lakh people engaged in weaving and allied activities. As a result of effective government intervention through financial assistance and the implementation of various developmental and welfare schemes, this industry has been able to withstand competition from the power loom and mills. Handloomindustry is unparalleled in its flexibility and versatility, permitting the experimentation and encouraging innovations and creativity. The strength of handloom industrylies in the introduction of innovative designs, which cannot be replicated by the power loom sector. Thus, handloom forms a part of the heritage of India and demonstrates the richness and diversity of our country and the artistry of the weavers.

At present, the handloom industry is facing multiple problems that some other sectors do not have. Despite the fact that the state and federal governments are consistently pursuing development in the productivity and marketing of the handloom sector, weavers continue to face a severe livelihood crisis. In order to make the sector profitable, the problems should be identified and the strengths and weaknesses should be estimated. Therefore, the objective of this paper is to focus on the problems of the handloom industry and further suggest suitable actions or remedial measures.

OBJECTIVES: The following are the important objectives of this paper:

1. To analyse the reasons for unprofitability of the handloom sector in Nellore district;
2. To study the pre-loom processing issues of the handloom sector in the district; and
3. To examine the major problems faced by the handloom sector in the district.

SAMPLING

Primary data is collected from the selected handloom weavers in SPSR Nelloredistrict. All the handloom weavers in the district during 2020 are listed out. Using Random Sampling, a sample of 256 weavers isselected at random from the list of2560 which equals to 10 percent after eliminating the defunct and sick units.

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ANALYSIS OF THE WEAVER'S PROFIT

Table-1 shows that the majority of the handloom independent weavers 132 (51.56 percent) have remarked, out of which 33 weavers (25 percent) said competition from power loom products and 27 weavers (20.45 percent) have recorded high cost of production and 21 weavers (15.91 percent) said middlemen involvement is the main reason for not getting a reasonable profit, while 19 respondents (14.39 percent) of weavers mentioned that it is because of the high cost of labour and 16 weavers (12.12 percent) each have the lack of government involvement and lack of marketing facilities as the main reasons for not getting reasonable profits.

The master weavers out of 41 (16.02 percent) respondents cited the majority of 9 respondents each (21.95 percent) of competition from power loom products and the high cost of labour involvement as the major reasons for not getting a reasonable profit. 7 respondents (17.07 percent) of master weavers think lack of marketing facilities, whereas 6 each (14.63 percent) of lack of government involvement, middlemen involvement, and the master weavers think high cost of production is the hindrance that diminishes reasonable profits. Theweavers under middlemen out of 28 weavers, noticed the problem of the high cost of labour and the lack of marketing facilities, and 10.93 percent detected the lack of government involvement in earning profits satisfactorily.

Table-1

The respondents' reasons for not getting a reasonable profit

Problems	Independent Weaver	Master Weaver	Weavers under Middlemen	Co-op Weaver	Labour Weaver	Total
Lack of Govt. support	16 (12.12)	6 (14.63)	5 (17.86)	6 (28.57)	8 (23.53)	41 (16.02)
Middlemen involvement	21 (15.91)	6 (14.63)	3 (10.71)	2 (9.52)	4 (11.76)	36 (14.06)
Cost of production is high	27 (20.45)	4 (9.76)	4 (14.29)	2 (9.52)	3 (8.82)	40 (15.63)
Wages of labour is high	19 (14.39)	9 (21.95)	6 (21.43)	4 (19.05)	2 (5.88)	40 (15.63)
Lack of Marketing Facilities	16 (12.12)	7 (17.07)	6 (21.43)	3 (14.29)	6 (17.65)	38 (14.84)
Competition from power looms	33 (25.00)	9 (21.95)	4 (14.29)	4 (19.05)	11 (32.35)	61 (23.83)
Total	132 (100.00) (51.56)	41 (100.00) (16.02)	28 (100.00) (1094)	21 (100.00) (8.20)	34 (100.00) (13.28)	256 (100.00) (100.00)

Source: Primary Data

Note: Figures in parentheses indicate percentages to total.

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The cooperative weavers out of 21 (8.20 percent) wavers, of which 28.57 percent have the lack of government support, 19.05 percent each of the high cost of labour and competition from power loom products. 14.29 percent conveyed by weavers' problem of the lack of marketing facilities and middlemen's involvement, the high cost of production having noticed 9.52 percent each. The labour weavers out of 34 (13.28percent), with competition from power loom products accounting for 32.35 percent, a lack of government involvement accounting for 23.53 percent, a lack of marketing facilities accounting for 17.65 percent, middlemen accounting for 11.76 percent, high labour costs observed at 8.82 percent, and high production costs accounting for 5.88 percent.

On the whole, it can be concluded that the major obstructive reasons for not getting reasonable profits are competition from power loom products, lack of government involvement, high cost of production, high wages of labor, etc.

ANALYSIS OF THE WEAVER'S PROBLEMS

The particulars of problems encountered in pre-loom process requirements are presented in Table-2. It could be seen from the table weavers under independents that the majority of respondent weavers (39.39 percent) take help from the members of their families, while 15.91 percent of weavers hire labour help, 13.64 percent of them take relatives' help, 11.36 percent of them take friends' help, and 8.33 percent of the members of their neighbor's help. However, only 1.52 percent of respondents use the government to assist them in pre- loom processing.

In the case of individual categories, the majority of master weavers out of 41 respondents engage in hired labour, and 26.83 percent capture family member's help, 14.63 percent gain from government help, and 4.88 percent each of organisation help, friends' help, relatives' help, and neighbor's help. The majority of weavers under middlemen are 28 respondents, out of which 32.14 percent of family help, 21.43 percent of hire labour, 10.71 percent of friends' help, and the remaining all categories have 7.14 percent each, except relatives' help and government help.

Under labour weavers out of 34 respondents, 38.24 percent acquired from family's help, 14.71 percent each obtained from hiring labour help and friends' help, and 8.82 percent gained from relatives' help, neighbours' help, colleagues' help, and organisation help, with 5.88 percent each. 21 respondents under cooperative weavers, out of which prefer to take family help, hire labour help, friends' help, neighbors' help, colleagues' help, relatives' help, others, government help, and organisation help, respectively.

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It can be concluded that a higher percentage of weavers from all categories mostly prefer and take their family support and help than the rest for pre-loom processing in the area of study.

Table-2
Pre-loom process requirement

Item	Independent Weaver	Master Weaver	Weaver under Middle men	Co-op Weaver	Labour Weaver	Total
Family's help	52 (39.39)	11 (26.83)	9 (32.14)	4 (19.05)	13 (38.24)	89 (34.77)
Neighbor's help	11 (8.33)	2 (4.88)	2 (7.14)	2 (9.52)	2 (5.88)	19 (7.42)
Hire Labour	21 (15.91)	12 (29.27)	6 (21.43)	4 (19.05)	5 (14.71)	48 (18.75)
Colleagues help	6 (4.55)	3 (7.32)	2 (7.14)	2 (9.52)	2 (5.88)	15 (5.86)
Friends help	15 (11.36)	2 (4.88)	3 (10.71)	3 (14.29)	5 (14.71)	28 (10.94)
Relatives help	18 (13.64)	2 (4.88)	1 (3.57)	2 (9.52)	3 (8.82)	26 (10.16)
Govt. help	2 (1.52)	6 (14.63)	1 (3.57)	1 (4.76)	1 (2.94)	11 (4.30)
Organization help	3 (2.27)	2 (4.88)	2 (7.14)	1 (4.76)	2 (5.88)	10 (3.91)
others	4 (3.03)	1 (2.44)	2 (7.14)	2 (9.52)	1 (2.94)	10 (3.91)
Total	**132** (100.00)	**41** (100.00)	**28** (100.00)	**21** 100.00()	**34** (100.00)	**256** (100.00)

Source: Primary Data
Note: Figures in parentheses indicate percentages to total.

The data regarding the problems that the respondent weavers face during the process of product or weaving is represented in Table-3. The highest percentage 23.44 percent of respondent weavers of all categories remarked that they face problems during the process of weaving due to lack of cooperation with helpers. With a small gap 21.09 percent of them have pointed out family problems as their problem, while 20.70 percent have mentioned unfavourable climatic conditions. A shortage of raw materials is another problem, though it is mentioned by a percentage of respondents (17.19 percent). Inefficiency of workers or lack of skilled workers has been noted at 16.02 percent. The lowest percentage of handloom workers has a 14.45 percent power shortage and a negligible percentage of workers is uneducated (7.81 percent).

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Based on the responses of individual category wise respondents, it is observed that the majority of weavers from all categories are independent weavers (51.56 percent), out of which 33 respondents are facing family problems, 27 respondents are facing non-cooperation with helpers, and 24 respondents are facing a lack of skilled workers. As per the master weavers (16.02 percent), out of which 12 respondents faced problems due to climatic conditions, 11 respondents faced non-cooperation with helpers, and 9 handloom weavers faced family problems. The weavers under middlemen (10.94 percent) out of which 8 weavers are facing problems due to a shortage of raw materials, 7 people are facing non- cooperation with helpers, and 6 weavers are facing problems due to unfavourable climatic conditions.

Table-3

Problems during product processing

Problems	Independent Weaver	Master Weaver	Weavers under Middlemen	Co-op Weaver	Labour Weaver	Total
Climatic conditions	23	12	6	5	7	53 (20.70)
Power shortage	17	7	4	3	6	37 (14.45)
Non-cooperation with helpers	27	11	7	6	9	60 (23.44)
Shortage of raw materials	20	8	8	3	5	44 (17.19)
Family problems	33	9	5	3	4	54 (21.09)
Lack of skilled workers	24	4	3	4	6	41 (16.02)
Un-education workers	11	2	1	2	4	20 (7.81)
Total	132 (51.56)	41(16.02	28(10.94)	21(8.20)	34(13.28	256 (100.00

Source: Primary Data

Note: Figures in Parentheses indicate percentages to total.

The cooperative weavers (8.20 percent) out of which 6 respondents faced problems of non-cooperation with helpers, 5 persons are faced problems with non-climatic conditions, and4 weavers faced problems of lack of skilled workers. The labour weavers (13.28 percent), outof which 9 weavers faced problems through non-cooperation with helpers, 7 respondents faced obstacles through unfavourable conditions, and 6 respondents each faced problems through power shortage and lack of skilled workers.

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Overall, weavers have felt that non-cooperation with helpers is the major problematic obstacle during the product process. The independent wavers, the weavers under middlemen, the cooperative weavers and master weavers, and labour weavers have mentioned that the major problems during product processing are family problems, climatic conditions, and shortage of raw materials. On the whole, it can be concluded that non-cooperation with helpers is the major problem during product processing.

GENERAL PROBLEMS FACED BY THE HANDLOOM INDUSTRY

The handloom units encountered several teething problems from different angles that greatly hampered the successful functioning of the handloom units. Ten major problems were identified and analysed in Table-4. The problems encountered by the handloom owners in the district as per their opinion. 35 respondents have been noticed as the major problem with the lack of infrastructural facilities. 33 respondents reported a lack of interest in this trade by future generations; 30 weavers reported a lack of government credit; 29 respondents reported a lack of raw materials; 25 weavers reported a lack of extension; and 23 respondents reported a lack of basic education.

As could be observed from the table, a considerable number of 132 units (51.56 percent) encountered problems with independent weavers.Among these, lack of infrastructural facilities constituted the largest proportion. The second highest proportion has been constituted by the unavailability of credits from the government and a lack of interest from future generations in this trade. The third largest proportion is constituted of the unavailability of raw materials. Of these, about 41 (16.02 percent of) respondents faced problems with master weaver, of these, lack of infrastructural facilities accounts for a large percentage. The unavailability of raw materials, lack of extension and lack of interest offuture generations in this trade constituted the second largest proportion.

About 28 (about 10.94 percent of) weavers got problems with their weavers working under middle men. Out of 28 units faced with the problem, the major sufferers were lack of infrastructural facilities and unavailability of credits from government respondents. Weavers were confronted with this problem. Co-operative weavers also seemed to be an important problem for the study's weavers at 21 or about 8.20 percent of the units were confronted with this problem. Among those who faced the problem of co-operative weavers, lack of extension constituted the largest proportion. The labour weavers also hampered the smooth functioning of the weaving. About 34 weavers, or 13.28 percent of the units, were affected by the labour weavers due to various problems.

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Handloom weavers are still using the same old method of weaving and there is no improvement, which is followed by major problems like lack of new designs, uncooperative workers, higher cost of production, low capacity of loom, frequent repair of looms, fluctuation in yarn price, quality of yarn, late yarn supply, lack of training and shortage of yarn, inadequate storage, overstock due to over production and overstock due to low demand,etc.

Table-4
The general problems faced by the handloom industry

Problems	Independent Weaver	Master Weaver	Weaver under Middle men	Co-op Weaver	Labour Weaver	Total
Unavailability of raw materials	15 (11.36)	6 (14.63)	3 (10.71)	2 (9.52)	3 (8.82)	29 (11.33)
Lack of infrastructural facilities	17 (12.88)	7 (17.07)	4 (14.29)	2 (9.52)	5 (14.71)	35 (13.67)
Lack of proper training	10 (7.58)	3 (7.32)	3 (10.71)	1 (4.76)	3 (8.82)	20 (7.81)
Lack of marketing system	12 (9.09)	2 (4.88)	2 (7.14)	1 (4.76)	3 (8.82)	20 (7.81)
Unavailability of credits from Government	16 (12.12)	4 (9.76)	4 (14.29)	2 (9.52)	4 (11.76)	30 (11.72)
Lack of Extension	11 (8.33)	6 (14.63)	2 (7.14)	4 (19.05)	2 (5.88)	25 (9.77)
Lack of Basic Education	13 (9.85)	2 (4.88)	2 (7.14)	3 (14.29)	3 (8.82)	23 (8.98)
Less wages rate in reeling industry	10 (7.58)	1 (2.44)	2 (7.14)	2 (9.52)	2 (5.88)	17 (6.64)
Lack of interest of future generation in this trade	16 (12.12)	6 (14.63)	4 (14.29)	2 (9.52)	5 (14.71)	33 (12.89)
Lack of financial resources	12 (9.09)	4 (9.76)	2 (7.14)	2 (9.52)	4 (11.76)	24 (9.38)
Total	132 (100.00) (51.56)	41 (100.00) (16.02)	28 (100.00) (10.94)	21 (100.00) (8.20)	34 (100.00) (13.28)	256 (100.00)

Source: Primary data
Note: Figures in parenthesis indicate percentages to total.

PROBLEMS THAT DRIVE WEAVERS TO COMMIT SUICIDE

The particulars of the problems that have led to commit suicide by the weavers are depicted in Table-5. The data reflects various types of problems that ruined the lives of different categories of weavers, leading to their committing suicide. If ranking is given to the type of problem suffered by the number of people, the major problem suffered by the

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majority of weavers from all categories, 19.53 percent, which stands at rank 1 in the area of study, is credit force. The involvement of middlemen was the second major problem that worried and grieved the greatest number of weavers of all categories (16.41percent), followed by a lack of financial support, which was the third highest problem faced by 13.67 percent of weavers.Lack of marketing facilities is the fourth highest problem faced by 10.16 percent. Due to power loom products is the fifth highest problem faced by 9.38 percent. The rise in yarn prices and a lack of worker problems are ranked sixth and seventh, respectively, with family problems ranking eighth and a lack of government assistance ranking ninth.

Looking into problems faced by category wise weavers, it is understood that the majority of weavers, comprising of independent weavers 132 (51.56 percent), master weavers 41 (16.02 percent), weavers under middlemen 28 (10.94 percent) and weavers under cooperative 21 (8.20 percent), and labour weavers 34 (13.28 percent), suffer mainly from credit force, middlemen involvement and lack of financial support, which nearer to 50 percent feel credit force.

The credit force has the highest percentage of independent weavers (19.70 percent).The highest percentage of master weavers (21.95 percent of middlemen involvement), weavers under middlemen (17.86 percent of credit force), under cooperative weavers (19.05 percent of lack of government assistance), and labour weavers (23.53 percent of credit force) face problems from the involvement of middlemen, whereas independent weavers face problems due to competition from the products of power looms and cooperativeweavers face misery due to harassment of moneylenders.

Overall, the majority of respondent weavers from all categories commit suicide as a result of a lack of government assistance, competition from power loom products, moneylender harassment and involvement, family problems, and a rise in yarn prices in the area of study.

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Table-3

Problems that drive weavers to commit suicide

Problems	Independent Weaver	Master Weaver	Weaver under Middle men	Co-op Weaver	Labour Weaver	Total	Rank
Credit Gave	26 (19.70)	8 (19.51)	5 (17.86)	3 (14.29)	8 (23.53)	50 (19.53)	1
Middlemen involvement	21 (15.91)	9 (21.95)	4 (14.29)	2 (9.52)	6 (17.65)	42 (16.41)	2
Due to power loom products	11 (8.33)	5 (12.20)	3 (10.71)	3 (14.29)	2 (5.88)	24 (9.38)	5
Lack of financial support	15 (11.36)	8 (19.51)	4 (14.29)	2 (9.52)	6 (17.65)	35 (13.67)	3
Hike in yarn price.	13 (9.85)	2 (4.88)	4 (14.29)	2 (9.52)	2 (5.88)	23 (8.98)	6
Lack of govt. assistance	9 (6.82)	2 (4.88)	3 (10.71)	4 (19.05)	5 (14.71)	23 (8.98)	6
Lack of marketing facilities	17 (12.88)	3 (7.32)	2 (7.14)	3 (14.29)	1 (2.94)	26 (10.16)	4
Family problems	13 (9.85)	2 (4.88)	2 (7.14)	--	3 (8.82)	20 (7.81)	7
Lack of workers problems	7 (5.30)	2 (4.88)	1 (3.57)	2 (9.52)	1 (2.94)	13 (5.08)	8
Total	132 (51.56)	41 (16.02)	28 (1094)	21 (8.20)	34 (13.28)	256 (100.00)	

Source: Primary data

Note: Figures in parenthesis indicate percentages to total.

The weaver's ill-health problems after the weaving operation are presented in Table-6. As could be seen from the table, the weavers' assessment of body pain was done through self-reported body discomfort ratings based on 13 point rating scales along with the frequency and severity of occurrence of pain among 256 weavers for performing weaving operations. Weavers reported the highest rates of elbow joint pain (12.89 percent), lower back pain (11.72 percent), shoulder pain (10.55 percent), neck pain (10.16 percent), wrist pain (8.98 percent), and knee pain (8.59 percent).

From subjective assessment for frequency of pain, there are 32. Out of them, 6weavers experienced shoulder pain, 4 respondents experienced elbow joint pain, 3 weavers each of leg pain, wrist pain, and knee pain, and 2 respondents each for backbone pain, neck

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pain, problems with the lungs, thighs pain, hand pain, and one each for lower back pain, foot pain, and ankle pain.

Table-6
Frequency of ill-health problems of weaver's working on handloom

Body parts	Pain always	Pain frequently	Pain sometimes	Pain never	Total
Lower back	1	3	5	2	11 (4.30)
backbone	2	6	16	6	30 (11.72)
Shoulder	6	7	11	3	27 (10.55)
Neck	2	6	14	4	26 (10.16)
Problem of lungs	2	3	6	2	13 (5.08)
Leg	3	6	7	2	18 (7.03)
Thighs	2	4	3	3	12 (4.69)
Foot	1	7	10	1	19 (7.42)
Elbow joint	4	8	17	4	33 (12.89)
Hand	2	6	6	2	16 (6.25)
Wrist pain	3	5	11	4	23 (8.98)
Knee	3	4	13	2	22 (8.59)
Ankle	1	2	2	1	6 (2.34)
Total	32 (12.50)	67 (26.17)	121 (47.27)	36 (14.06)	256 (100.00)

Source: Primary data
Note: Figures in parenthesis indicate percentages to total.

Frequency of ill-health problems frequently noticed 67 out of which 8 weavers have faced elbow joint pain, 7 weavers each have shoulder pain and foot pain, and 6 members each have different problems of backbone pain, neck pain, leg pain, hand pain, and 5 weavers illuminated the problem of wrist pain.

A significant number of weavers reported pains after treadle operation, with 17 reporting elbow joint pains, 16 reporting backbone pain, 14 reporting neck pain, and 11 reporting shoulder pain. It was discovered that the pains sometimes reported in leg, lungs, hand, lower back, thighs, and ankle.

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Weavers reported without pain after treadle operation noticed out of 36 respondents,of which 6 weavers had no backbone pain, 4 respondents each conveyed without pain neck, elbow joint, wrist pain, and 3 weavers each had shoulder and thighs pain.

In overall observation, the majority of respondent weavers from all categories reported body pains after working on handlooms due to inadequate foot support for ankle andtoe, which indicates the presence of ergonomic issues and the need for ergonomic intervention. Hence, an ergonomic design approach to modify the different components of theworkstation which interact with the body parts such as elbow joint, backbone, shoulder, neck,wrist pain, and knee during operation will help to reduce pain.

CONCLUSIONS

On the basis of the study, the following conclusion may be drawn. The descriptive study showed that poor working conditions and musculoskeletal problems in handloomworkers occurred at a high rate. More than 86 percent of weavers are currently experiencing musculoskeletal pain. Thus, improvement of working conditions and control of musculoskeletal problems seemed essential. The elimination of problems that likely contribute to the weavers' suffering is the prime need of the hour. Since prolonged sitting has been documented to be one of the problems affecting the musculoskeletal system in these settings, weavers should introduce frequent rest pauses between two consecutive work cycles by taking short breaks. Musculoskeletal problems were positively associated with age, gender, individual income, family income, family size, job experience, working hours perday, working days per week, general working conditions, and working posture.

The study focuses on the availability of various government schemes available to support handloom weavers, as well as the various problems faced by traditional handloom weavers, including financial problems. The study finds that the present profitabilty is very meager, which is insufficient to meet their day-to-day activities. The financial support from the government is very limited. The wage hike is the need of the hour and the reasonable wages should be provided to them without any delay. The immediate intervention of the government is essential for the survival of the handloom weavers.

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Significance of mathematical and statistical principles in electroanalytical chemistry

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Abstract

This attempt is to explain the role of mathematics and statistical principles standard deviation ,relative standard deviation and correlation coefficient in estimations by taking electroanalitical methods of analysis as a case. This computing residual amounts of pesticides present in environmental samples by applying electro chemical technique adsorptive stripping voltammetry. Average amounts for ten replicates founded by using carbon nano tubes paste electrodes as working electrodes. statistical concepts such as standard deviation and correlation coefficient and in all the findings in this approach all the possible errors are minimised and accuracy is maximised. Water samples of various areas are collected and investigated for pesticide residues before and after the application of pesticides.

Key words: standard deviation ,relative standard deviation , correlation coefficient ,pesticides, adsorptive stripping voltammetry, carbon nano tubes paste electrodes ,water samples.

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Introduction

In statistics, the standard deviation is a measure of the amount of variation or dispersion of a set of values. A low standard deviation indicates that the values tend to be close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the values are spread out over a wider range.Standard deviation may be abbreviated **SD**, and is most commonly represented in mathematical texts and equations by the lower case Greek letter sigma **σ**By using standard deviations, a minimum and maximum value can be calculated that the averaged weight will be within some very high percentage of the time (99.9% or more). If it falls outside the range then the production process may need to be corrected. Statistical tests such as these are particularly important when the testing is relatively expensive. For example, if the product needs to be opened and drained and weighed, or if the product was otherwise used up by the test.In experimental science, a theoretical model of reality is used. Particle physics conventionally uses a standard of "**5 sigma**" for the declaration of a discovery. A five-sigma level translates to one chance in 3.5 million that a random fluctuation would yield the result.

In statistics, the Pearson correlation coefficient (PCC)is the ratio between the covariance of two variables and the product of their standard deviations; thus it is essentially a normalized measurement of the covariance, such that the result always has a value between −1 and 1. As with covariance itself, the measure can only reflect a linear correlation of variables, and ignores many other types of relationship or correlation. As a simple example, one would expect the age and height of a sample of teenagers from a high school to have a Pearson correlation coefficient significantly greater than 0, but less than 1 (as 1 would represent an unrealistically correlation).

Voltammetry is a category of electroanalytical methods used in analytical chemistry and various industrial processes. In voltammetry, information about an analyte is obtained by measuring the current as the potential is varied. The analytical data for a voltammetric experiment comes in the form of a voltammogram which plots the current produced by the analyte versus the potential of the working electrode.

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Pesticides which remain in the soil or on the treated surface are also often called residual chemicals[1-7].When residual pesticides get into the environment they can remain poisonous and active for many years. If applied incorrectly or used in the wrong place, these chemicals may spread to other land areas and possibly to the water supply.

There are good reasons (advantagespesticides are very effective. This means that nearly all the target pests which come in contact with these pesticides are killed Results are quick. This means the pests are killed within a very short time.

Using pesticides can be an economical (cheap) way of controlling pests. Pesticides can be applied quickly and there is not the high labour cost which might apply to other methods of control, such as removing weeds by hand.

If pesticides are not used correctly, they can affect human health or cause serious injury or death to the pesticide operator, other people or household pets. Pesticides can also directly affect other non-target animals. For example, a gardener spraying his garden to kill caterpillars will probably also kill harmless lady bird beetles and praying mantises. If pesticides are used incorrectly or applied wrongly, they may find their way into places where they are not wanted, for example, they might be washed into rivers or into the soil. In this article an elstroanalytical method voltammetry supported by statistical findings was applied.

Instruments and reagents

Electro analytical determinations conducted using a model meterohm Auto Lab 101 PG stat (Netherlands). CNTPE was used as working electrode for differential pulse adsorptive stripping voltammetry and cyclic voltammetry. pH measurements were carried out with an Eutech PC_510 cyber scan. Meltzer Toledo (Japan) Xp26 delta range micro balancer were used to weigh the samples during the preparation of standard solutions. All the experiments were performed at 250C.

All reagents used are analytical reagent grade. Double distilled water was used throughout the analysis. In the present investigation universal buffers of pH 4.0 was used as supporting electrolytes and are prepared by using 0.2 M boric acid, 0.05M citric acid and 0.1M trisodium orthophosphate solutions.

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Measurements and calculations

In this standard addition method, the voltammogram of the unknown is first recorded after which a known volume of standard solution of the same electro active species is added to the cell and second voltammogram is taken. From the magnitude of the peak height, the unknown concentration of species may be calculated using the following equations.

$$C\,(\text{un known}) = \frac{C_s x V}{V_s x i_2} x\, i_1$$

Result And Discussions

Well resolvable and reproducible peak obtained for each sample is useful for the analysis of water samples. The optimum pH to get well defined peak for the detection is found to be 4.0. The peak current is found to vary linearly with the concentration of the pesticide over the range 1.0×10^{-5}M to 1.0×10^{-9}M. The lower detection was limit found to be 1.02×10^{-9}M. The correlation coefficient and relative standard deviation (for 10 replicates) obtained using the above procedure [8-15].

Recovery experiments

A stock solution (1.0×10^{-3} M) of each sample is prepared in dimethyl formamide. In voltammetric cell, 1 mL of standard solution is taken and 9 mL of the supporting electrolyte (pH 4.0) is added to it. Then the solution is de aerated with nitrogen gas for 10 min. after obtaining the voltammogram, small additions of standard solution are added and the voltammograms are recorded under similar experimental conditions. The optimum conditions for analytical estimation at pH 4.0 are found to be pulse amplitude of 25 mV, applied potential of -0.35V and scan rate 40 $mVs.^{-1}$.

Water samples are collected from paddy fields which sprayed by the pesticides under investigation 48 hours after spraying the pesticides. These samples were filtered through a Whatman No.41 filter paper and Aliquots of water samples were taken in a 25mL graduated tube, to it buffer solution was added and analyzed as described above. The recoveries of samples

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obtained in water samples ranged from 51.00 to 57.00% and the results are summarized in Table 1.0.

Table 1.0: Recoveries of herbicides in soil samples

Name of the pesticide	Amount added (mg/L)	Amount found (mg/L)	*Recovery (%)	Standard deviation
1.attrazine	4.0	2.15	53.75	0.07
2.Dicamba	4.0	2.36	59.00	0.05
3.trifluralin	4.0	2.31	57.75	0.16
4.cyanazine	4.0	2.25	56.25	0.06
5.pendimethalin	4.0	2.10	52.50	0.17

***Average of 10 replicates**

Conclusions

In this attempt statistical parameters for the determination of pesticide residues satisfactory applied to interpret the instrumental out puts without considerable errors. And during the estimations pollution arises due to heavy metal electrodes such as mercury electrodes is avoided by using carbon electrodes.

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Application of polynomials in computing weedicides in environmental samples

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Abstract

This attempt is to determine the trace amounts of weedicides present in environmental samples by applying electro chemical technique adsorptive stripping voltammetry. Average amounts for ten replicates founded by using carbon nano tubes paste electrodes as working electrodes.a cocept of polynomials in math matics and statistical concepts such as standard deviation and correlation coefficient and in all the findings in this investigation with higher degree of accuracy. Water samples of various areas are collected and investigated for weedicide residues before and after the application of weedicide.

Key words: weedicides, adsorptive stripping voltammetry, carbon nano tubes paste electrodes ,water samples.

Introduction

althuogh the fact that weedicides are useful for the control of various undesirable plants in crops at different levels. They are risky because they can poison the land, the water and the air. Some weedicides do disintigrate for a long time. These types of harmfull chemicals regularly usedto sustain yields [1-7].

When residual pesticides get into the environment they can remain poisonous and active for many years. If applied incorrectly or used in the wrong place, these chemicals may spread to other land areas and possibly to the water supply.

There are good reasons (advantagespesticides are very effective. This means that nearly all the target pests which come in contact with these pesticides are killed Results are quick. This means the pests are killed within a very short time.

Using weedicide can be an economical (cheap) way of controlling weeds and can be applied quickly and there is not the high labour cost which might apply to other methods of control, such as removing weeds by hand.

Instruments

Electro analytical determinations conducted using a model meterohm Auto Lab 101 PG stat (Netherlands). CNTPE was used as working electrode for differential pulse adsorptive stripping voltammetry and cyclic voltammetry. pH measurements were carried out with an Eutech PC_510 cyber scan. Meltzer Toledo

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(Japan) Xp26 delta range micro balancer were used to weigh the samples during the preparation of standard solutions. All the experiments were performed at 25^0C.

Reagents

All reagents used are analytical reagent grade. Double distilled water was used throughout the analysis. In the present investigation universal buffers of pH 4.0 was used as supporting electrolytes and are prepared by using 0.2 M boric acid, 0.05M citric acid and 0.1M trisodium orthophosphate solutions.

Measurements and calculations

In this standard addition method, the voltammogram of the unknown is first recorded after which a known volume of standard solution of the same electro active species is added to the cell and second voltammogram is taken. From the magnitude of the peak height, the unknown concentration of species may be calculated using the following equations.

$$\text{C (un known)} = \frac{C_s xV}{V_i xi_2} x\, i_1$$

Computation of recoveries done by using quadrqtic polynoial cocept of math matics

$F(x)=a_n x^n+bx^{n-1}+a_{n-2}\, x^{n-2}\ldots\ldots\ldots\ldots+rx+s$(general)

$ax^2+bx+c=0$(quadratic)

and for better determinations statistical concepts such as standard deviation and relative standard deviation and corilation coefficient were applied[23].

Result And Discussions

Well resolvable and reproducible peak obtained for each sample is useful for the analysis of water samples. The optimum pH to get well defined peak for the detection is found to be 4.0. The peak current is found to vary linearly with the concentration of the pesticide over the range 1.0×10^{-5}M to 1.0×10^{-9}M. The lower detection was limit found to be 1.02×10^{-9}M. The correlation coefficient and relative standard deviation (for 10 replicates) obtained using the above procedure [8-15].

Recovery experiments

A stock solution (1.0×10^{-3} M) of each sample is prepared in dimethyl formamide. In voltammetric cell, 1 mL of standard solution is taken and 9 mL of the supporting electrolyte (pH 4.0) is added to it. Then the solution is de aerated with nitrogen gas for 10 min. after obtaining the voltammogram, small additions of standard solution are added and the voltammograms are recorded under similar experimental conditions.

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The optimum conditions for analytical estimation at pH 4.0 are found to be pulse amplitude of 25 mV, applied potential of -0.35V and scan rate 40 $mVs.^{-1}$.

Water samples are collected from paddy fields which sprayed by the pesticides under investigation 48 hours after spraying the pesticides. These samples were filtered through a Whatman No.41 filter paper and Aliquots of water samples were taken in a 25mL graduated tube, to it buffer solution was added and analyzed as described above. The recoveries of samples obtained in water samples ranged from 51.00 to 57.00% and the results are summarized in Table 1.0.

Table 1.0: Recoveries of weedicides in water samples

Name	Amount added (mg/L)	Amount found (mg/L)	*Recovery (%)	Standard deviation
1.Aldicarb	5.0	3.15	53.75	0.07
2.Thiodicarb	5.0	3.36	59.00	0.05
3.Chlorpropham	5.0	3.31	57.75	0.16
4.Fenclorim	5.0	3.25	56.25	0.06
5.Isoxidefen	5.0	3.10	52.50	0.17
6.Fenclorazole	5.0	3.18	54.50	0.07
7.Phenothrin	5.0	3.22	55.00	0.15
8.Bynapycril	5.0	3.26	59.45	0.03

***Average of 10 replicates**

Conclusions

In this approach statistical parameters and polynomial concept were used for the estimation of weedicide residues satisfactory applied to interpret the instrumental out puts without considerable errors. And during the estimations pollution arises due to heavy metal electrodes such as mercury electrodes is avoided by using carbon electrodes.

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Finding of persistence of fungicides in water samples by using electro analytical techniques

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Abstract
In this approach the trace quantities of fungicide samples due to variety of activities present in vegetable units by electro chemical technique adsorptive stripping voltammetry. Mean quantities for ten replicates founded by via carbon nano tubes paste electrodes as working electrodes. Arithmetical concepts such as standard deviations and correlation coefficient and in the entire conclusion in this effort all the probable errors are monitored and accurateness is maximised. Water samples of various areas are collected and investigated for pesticide residues before and after the application of fungicides.

Key words: fungicide, adsorptive stripping voltammetry, carbon nano tubes paste electrodes ,vegetable matter.

Introduction

Regardless of the statistics that pesticides are valuable for the control of versitile pests, many of them are hazardous chemicals. They are perilous because they can poison the land, the water and air. Certain pesticides do not break down for a long time. These types of pesticides are often used when something must be protected from pest attack for a long period of time, for example, protecting houses from termite attack. Pesticides which remain in the soil or on the treated surface are also often called residual chemicals[1-5]. When residual pesticides get into the environment they can remain poisonous and active for many years. If applied incorrectly or used in the wrong place, these chemicals may spread to other land areas and possibly to the water supply.

If pesticides are not used correctly, they can affect human health or cause serious injury or death to the pesticide operator, other people or household pets. Pesticides can also directly affect other non-target animals. For example, a gardener spraying his garden to kill caterpillars will probably also kill harmless lady bird beetles and praying mantises. If pesticides are used incorrectly or applied wrongly, they may find their way into places where they are not wanted, for example, they might be washed into rivers or into the soil. In this article an elstroanalytical method voltammetry supported by statistical findings was applied.

Apparatus and Chemicals

Electro analytical determinations conducted using a model meterohm Auto Lab 101 PG stat (Netherlands). CNTPE was used as working electrode for differential pulse adsorptive stripping voltammetry and cyclic

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voltammetry. pH measurements were carried out with an Eutech PC_510 cyber scan. Meltzer Toledo (Japan) Xp26 delta range micro balancer were used to weigh the samples during the preparation of standard solutions. All the experiments were performed at 250C.

All reagents used are analytical reagent grade. Double distilled water was used throughout the analysis. In the present investigation universal buffers of pH 4.0 was used as supporting electrolytes and are prepared by using 0.2 M boric acid, 0.05M citric acid and 0.1M trisodium orthophosphate solutions.

Computation

In this standard addition method, the voltammogram of the unknown is first recorded after which a known volume of standard solution of the same electro active species is added to the cell and second voltammogram is taken. From the magnitude of the peak height, the unknown concentration of species may be calculated using the following equations.

$$C\ (\text{un known}) = \frac{C_s V}{V_s \Delta i_p} \times i_p$$

Findings and Analysis

Fine resolvable peak obtained for each sample is useful for the analysis of water samples. The optimum pH to get well defined peak for the detection is found to be 4.0. The peak current is found to vary linearly with the concentration of the pesticide over the range 1.0×10^{-5}M to 1.0×10^{-7}M. The lower detection was limit found to be 1.03×10^{-9}M. The correlation coefficient and relative standard deviation (for 10 replicates) obtained using

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IODIN MEDIATED SYNTHESIS AND CONSTRUCTION OF AROMATIC THIOUREAS FROM AMINES

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ABSTRACT

A new facile methodology for the synthesis of aromatic thioureas by desulphurization and addition reaction of the required amine, carbon disulphide and ammonia solution in the presence of DMSO solvent using iron at room temperature. The structures of the synthesized compounds were confirmed by IR, and, ^{1}H-NMR methods. The synthetic benefits of the presented methods are reflected in the operational simplicity, mild reaction conditions, short reaction times, high purity and yield of the products. Considering the commercial importance of thioureas, it should be emphasized that implementation of the optimal synthesis of thiourea determined good intermediate for the synthesis heterocyclic compounds having good biological activity from amines using iodine as a reagent.

INTRODUCTION

Thiourea is a very important functional group and good intermediate for the synthesis heterocyclic compounds such as benzothiozole,[1] imnothiazolines,[2] thiohydantoins,[3] 1,3,5-triazines,[4] 2-amino-oxazolidines[5] and other compounds such as minoxidil[6] and herbicides,[7] which have biological activity. In addition, thioureas are useful precursors in the synthesis of pharmaceutically important heterocycles[8] and *N*-alkyl or *N*-aryl imides.[9] Many methods for the synthesis of thioureas have been reported. for example, N-substituted thioureas are commonly prepared from the reaction of amines with alkali metal thiocyanates in the presence of a strong acid,[10] aroyl isothiocyanates with amines followed by basic hydrolysis,[11] isothiocyanates with ammonia or amines in two step reactions,[12] unsubstituted thioureas with primary amines with carbon disulfide in the presence of mercury acetate aqueous ammonia, primary alkyl amines at high temperature,[13] and disubstituted cyanamides with hydrogen chloride and hydrogen sulfide in the presence of ammonia.

Several new methods for the preparation of substituted thioureas have been recently reported.[14] Apart from previous reports still mild, efficient and environment friendly method is desired. Therefore, we wish to demonstrate the construction of thioureas from amines using cheap and readily available Iodine as reagent.

EXPERIMENTAL SECTION

Herein, we report a three-component reaction between amine, CS_2 and ammonia solution in the presence of DMSO solvent using iron at room temperature. The optimization of the reaction conditions was carried out with aniline as model substrate using different bases, solvents and Iodine at varied temperatures (Table 1). The best result was obtained when the reaction was pursued at room temperature using 1 eq of the Iodine with bases like Et_3N, Sodium acetate and $NaHCO_3$ in the presence of DMF affording the phenylthiourea (Scheme 1) in 95% conversion (Table 1, entries 5 & 101-11).

Table 1: Optimization reaction conditions for the synthesis thiourea.

X Y

Entry	Solvent	Base	Yield (%)
1	Ethanol	Et_3N	45
2	Ethyl acetate	Et_3N	80
3	DCM	Et_3N	75
4	DMSO	Et_3N	75
5	**DMF**	**Et_3N**	**95**
6	H_2O	Et_3N	ND
7	n-Hexane	Et_3N	ND
8	n-Heptane	Et_3N	ND
9	DMF	Pyridine	55
10	DMF	$NaHCO_3$	95
11	DMF	NaOAc	95
12	DMF	Na_2HPO_4	95
15	DMF	NaOAc	87
14	-	-	ND

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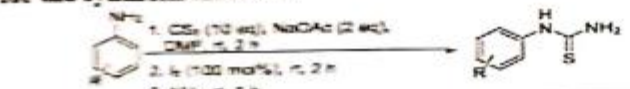
[a]Reaction conditions: Aniline (2 mmol), CS_2 (10 eq), Et_3N (2 eq), I_2 (100 mol%), Ammonia solution (2 ml) were stirred at room temperature in the presence of respective solvent for 5 h.

Firstly, the reaction was checked in the presence of different solvents. Among the solvents DMF gave target product in excellent yield. Other solvents like ethyl acetate, ethanol, DCM and DMSO could give target product in good yield. We have also examined with polar greenery solvent H_2O and no product was observed. Later we have checked with the non-polar solvents like n-Hexane and n-Heptane. Unfortunately, no non-polar solvent could give target product. The reaction with another organic base pyridine couldn't give expected product. However, the inorganic bases sodium bicarbonate, sodium acetate and disodium phosphate could give target products in good yield. Finally, the less amount of reagent like 50 mol % was examined, however the reaction to provide target product in moderate yield. The control experiment is confirmed that the reaction doesn't provide final product in the absence of solvent and base, and the starting material is recovered intact.

Having the optimal conditions in hand, we explored the scope of this procedure for the substrates having electron donating and electron withdrawing substituents on the aryl rings. In this connection the various substrates bearing electron donating and electron withdrawing groups were examined under the standard reaction conditions (Table 2). The phenyl ring having electron donating groups such as 4-methyl, 4-methoxy could give their respective aromatic thioureas (Table 2, entries 3-4) in high yield. The unsubstituted phenyl ring also gave target product in quantitative yield (table 2, entry 1). Electron withdrawing groups such as 4-fluoro and 4-chloro substituents gave their final products in 75-84% yield (Table 2, entries 2 and 7). The aryl ring having strong electron withdrawing group $-NO_2$ on second position gave no product (table 2, entry 6). 4-Cyano aniline activity was also examined under optimized reaction conditions, but unfortunately no reaction was observed. Later, the same reaction was tested using strong base, anhydrous potassium hydroxide (KOH) and no target product could observe. Subsequent optimization for the reaction led to increase in yield, we did the reaction with anhydrous potassium hydroxide (KOH) at 80 °C. Very interestingly the reaction could produce target product in moderate yield (Table 2, entry 10). Di-substituted and ortho-substituted aryl rings could obtain their respective thioureas in good yield (Table 2, entries 5 and 8).

Table 2: Substrate scope for the synthesis thioures.

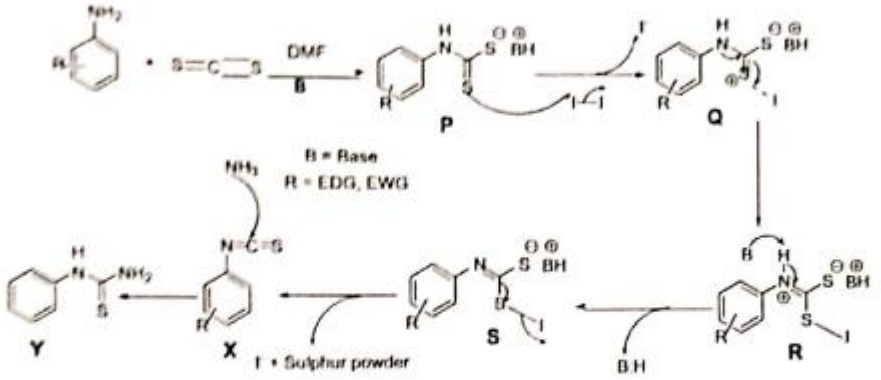


entry	Substrate	Product	Isolated yield (%)[a]
1			95
2			84
3			95
4			92
5			82
6			80[b]
7			75
8			81
9			88
10			86[c]
11			88
12			84

[a] Compounds were confirmed by ^1H and ^{13}C NMR analysis. [b] Base (KOH) (2 eq) and temp 85 °C were used.

MECHANISM OF THE REACTION

The mechanism of formation for phenyl thiourea from aniline is shown in below Scheme 1. The experimental evidence and from the literature report the mechanism is proposed. As we shown in scheme 1, aniline (I) reacts with carbon disulphide in the presence of base (Et_3N) and respective solvent to give thiocarbamate salt **P**. It may co-ordinate with iodonium and followed by remove the proton to afford the intermediate **S** *via* intermediate complexes **Q** and **R**. Desulfurization of **S** afforded diisocyanato **X** that reacts with ammonium to give target thiourea **Y**.



RESULT AND CONCLUSION

In conclusion, we have developed neat, clean and efficient methodology for the synthesis of aromatic thioureas. This reaction involved consecutive desulphurization and addition. The reactions are rapid and facile and accomplished under mild reaction conditions. All the reactions readily underwent optimized conditions to provide target products in moderate to excellent yield.

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SOCIO-ECONOMIC FACTORS OF HANDLOOM WEAVERS IN THE SPSR NELLORE DISTRICT

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The handloom weaving activity is one of the biggest unorganized economic activities in India. The handloom industry in India has a long tradition of outstanding artisanship that represents and preserves vibrant Indian culture. India's handloom artisans are globally known for their unique hand spinning, weaving, and printing style. They are based out in small towns and villages of the country which transfer skills from one generation to the next. The handloom industry is the country's largest cottage industry, with 23.77 lakh looms. The handloom activity is very pathetic and the present situations are pressing the weavers into poverty and depressing. In this paper, an attempt is made to study the socio-economic factors which are influencing the handloom weavers in the SPSR Nellore district. A detailed evaluation of Socio-economic factors that influence the Handloom weavers like gender, age, literacy level, Community, ration card, etc. is provided in this paper.

Keywords: Handloom industry,gender, age, literacy level, Community, and ration card.

INTRODUCTION

The handloom sector in India is one of the biggest unorganized economic activities. The handloom industry in India has a long tradition of outstanding artisanship that represents and preserves vibrant Indian culture. India's handloom artists are globally known for their unique hand spinning, weaving, and printing style. They are based out in small towns and villages of the country which transfer skills from one generation to the next. The handloom industry is the country's largest cottage industry, with 23.77 lakh looms. It is also the second-largest employment provider in the rural region employing more than 3.5 million people in direct and allied activities.

The Handloom weavers produce several traditional products such as sarees, dhotis, Kurtis & Kurtas, shawls, ghagra cholis, lungies, fashion accessories, bedspreads, etc. In the contemporary product category, the industry produces fashion fabrics, western dresses, bed linens, drapes, kitchen linen, decorative furnishings and rug durries, etc. The handloom sector of India has the advantage of being less capital intensive, eco-friendly, having less power consumption, and the ability to adapt to market conditions.According to the Handloom Census 2019-20, the industry employs about 35,22,512 handloom workers across the country.

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The industry primarily employs women workers with a share of 72.29 percent of the total handloom workers

At the moment, the socio-economic conditions of the handloom weavers are very pathetic and these situations are pressing the weavers into poverty and depressing. An effort is designed to evaluate the socio-economic factors of the handloom weavers in the SPSR Nellore district of Andhra Pradesh.A detailed evaluation is provided on the Socio-economic factors that are influencing the Handloom weavers in Nellore District with chosen characteristics such as gender, age, literacy level, Community, and ration card.

REVIEW OF LITERATURE

Mohsin Khan (2020)conducted a study to find the socio-economic condition of handloom weavers in Chirala Mandal of Andhra Pradesh. The main aim of the study is to collect data from 70 manual families and gather information on the financial situation of manual weavers in the village of Chirala in Andhra Pradesh. This analysis also gives a concise overview of the problems of the weavers of handlooms and the administrative arrangements for the welfare of handlooms that have been implemented in Andhra Pradesh. The main objectives of this study are to explore the socio-economic status of weavers in the handloom, such as earnings, health, etc. Analyze the issues of manufacturing, distribution, and consumption of weavers in the area studied. It was concluded from this study that 37% of weavers under 41-50(adult age) are employed. 31% of the weavers have finished secondary education and most of the people have left because of family backwardness. In 2018–19, 57 percent of the weavers invested less in education than Rs.6000. For consumption purposes during the year 2018-19, 40 percent of weavers spend their earnings of Rs.102001-Rs.251500.

Naga Raju (2018) has highlighted the socio-economic factors of handloom weavers. The study gives an overview of the history of the industry intending to determine its declining factors. It also tries to concentrate on aspects of the socio-economic factors of the weavers of the handle. Moreover, the sector's organizational issues are addressed. The study also gives wide indications about the possible consequences of the successive governments' different policies. The findings of this study are important for the industry to adopt modern technology and improve the social and economic factors in the households of handloom weavers. The analysis of the revenues of the sample weavers is also carried out regarding the type of loom used. Furthermore, in the event of fly shuttle pit looms, output per loom per day is low. The annual income of interviewees with the frame or semi-automatic wear can generate higher incomes because the wear and tear per day are also higher than the wear and

tear. The welfare schemes for women handloom workers can be explored further since more women have been involved in the handloom sector. This survey shows that most respondents favor their children to work for gold and government service. Independent weavers and weavers under master weavers are less interested in placing their children in their hereditary occupation and they feel strongly that the work of goldsmiths will provide their children with better livelihoods.

Tania Parvin and Sadika Haque (2017)in their study examined the livelihoods of Bangladesh's leading rural non-farm households known as handloom weavers. The study reveals that Bangladesh's weaver households are better at livelihoods than those provided by government services in most socio-economic indicators other than the level of education and theamount of funding It was therefore concluded that the contribution of the handloom industry to the solution of the unemployment problem and developing the social and economic factors of the rural households, the largest and most significant non-agricultural employment sector, cannot be denied in Bangladesh. However, there are also several challenges in this sector. Some of them have a market failure, while others include failure to meet production, capital cost, lack of product diversification, etc. This study, therefore, recommends the ways of improving these conditions, intending to enhance the social and economic factors of weavers in Bangladesh to their full potential.

Sandhya Rani Das (2015) undertook a study about the Socio-Economic Profile of Handloom Weaving Community in Bargarh District of Odisha state. The purpose of this study is to analyze the weavers' socio-economic situation and to provide possible guidelines to reduce their plight. The results of the research studies show a gradual shift between the weaving profession and government services because of the uncertainty in the sector and because the government is not paying attention to the declining state of the traditional weavers. The study has shown that weavers are confronted by several challenges, such as financial constraints, the lack of up-to-date machinery, poor work conditions, poor pay, and the less government support. It was concluded by the present study that Handloom weavers traditionally weave in the district of Bargarh because of their primary occupation, due to their poor socio-economic status. However, the aspect of socio-economic factors is decreasing due to different unfavorable factors. They are mostly wage weavers who work with the whole family for more than 8 hours per day. Most of the weavers work under master weavers' control. The findings were largely linked to techniques for improving the socio-economic factors of households in handloom weavers. Further, it is also suggested to study about the strength and weaknesses of the sector must be identified and estimated, even though

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handloom weaving has a lot of strengths but it is still in difficult social and economic factors through severe crises.

OBJECTIVES OF THE STUDY

The main objective of this paper is to evaluate the socio-economic factors influencing the Handloom weavers in the SPSR Nellore district.

SAMPLING

Primary data is collected from the selected Handloom Weavers in five administrative revenue divisions of SPSR Nellore district, viz. Nellore, Gudur, Kavali, Naidupeta and Atmakur. All the Handloom Weavers in the district from 2011-12 to 2020-21 are listed out. Using 'Stratified Random Sampling', a sample of 10 percent is selected at random from 3904 Handloom Weavers in the district during 2019-20. which equalsto 390weavers.

Table 1 describes the Revenue Division-wise of the respondents selected for the study. The district has been divided into Five Divisions like Nellore, Gudur, Kavali, Naidupeta, and Atmakuru. Table 1shows that out of 390 sample respondents taken for the study, 142 (36.4 percent) of the respondents belong to Nellore Division, 119(30.5 percent) of the respondents belong to Gudur Division, 96 (24.6 percent) of the respondents belong to Atmakuru Division, 18 (4.6 percent) of the respondents belong to Kavali Division and 15 (3.8 percent) of the respondents belong to Naidupeta Division. Hence, it can be concluded that a maximum of 36.4 percent of the respondents belong to Nellore Division which is in the district headquarters.

Table 1
Revenue Division-wise sample respondents

Revenue Division	Respondents	Percentage
Nellore	142	36.4
Gudur	119	30.5
Kavali	18	4.6
Naidupeta	15	3.8
Atmakuru	96	24.6
Total	**390**	**100.0**

Source: Field Survey, Data collected from the 390 sample Handloom Weavers

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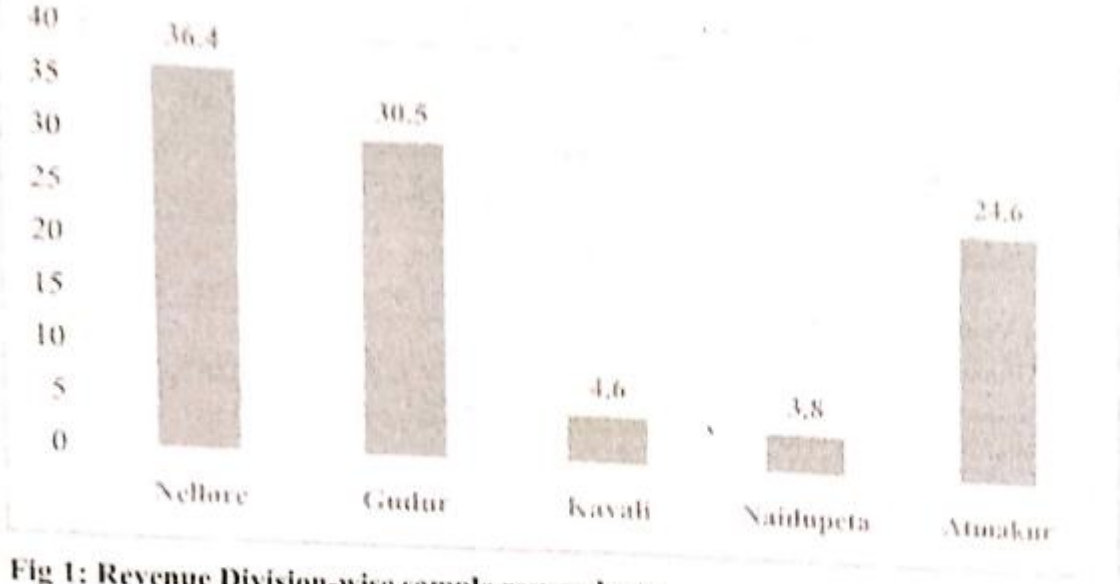

Fig 1: Revenue Division-wise sample respondents

Table 2 reveals that 294 (75.38 percent) respondents are male and 96 (24.62 percent) respondents are Femaleout of 390 sample respondents taken for the study. Therefore, it can be concluded that the majority 75.38 percent) of the respondents is Male.

In the Nellore division, out of 142 sample respondents taken for the study, 110 (77.46 percent) respondents are male and 32 (22.54 percent) respondents are Female. The greater part of 77.46 percent of the respondents are Male in the Nellore division. Out of 119 sample respondents, 93 (78.15 percent) of the respondents are male and 26 (21.85 percent) the respondents are Female. The gargantuan portion was 78.15 percent of the respondents are Male in the Gudur division. Out of 18 sample respondents, 12 (66.67 percent) the respondents are male and 6 (33.33 percent) respondents are Female. A huge portion 66.67 percent of the respondents are Male in the Kavali division.

In the Naidupet Division, sample of 9 (60 percent) respondents are male and 6 (40 percent) of the respondents are Female out of 15 sample respondents. The gigantic portion was 60 percent of the respondents are Male in the Naidupet division. Out of 96 sample respondents, 70 (72.92 percent) of the respondents are male and 26 (27.08 percent) respondents are Female. The enormous portion was 72.92 percent of the respondents are Male in the Atmakuru division.

Table 2
Division wise Male and Female of the Respondents in the Nellore District

Division/Gender	Nellore Division	Gudur Division	Kavali Division	Naidupet Division	Atmakuru Division	Total
Male	110 (77.46)	93 (78.15)	12 (66.67)	9 (60.00)	70 (72.92)	294 (75.38)
Female	32	26	6	6	26	96

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	(22.54)	(21.85)	(33.33)	(40.00)	(27.08)	(24.62)
Total	142 (100.00)	119 (100.00)	18 (100.00)	15 (100.00)	96 (100.00)	390 (100.00)

Source: Field Survey

Note: Figures in the bracket are the percentage of the respondents

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	6835	4	1708.75	1.3611	0.365207	5.19228
Within Groups	6277	5	1255.4			
Total	13112	9				

Taken from table 2,an ANOVA results in the calculated value of F is **1.3611**. The table value of F at a 5% level of significance for (4,5) degree of freedom is **5.1922**. As the calculated value is less than the table value, we accept the null hypothesis. It can conclude that there is no significant difference in the Male and female population of the handloom weavers Respondents.

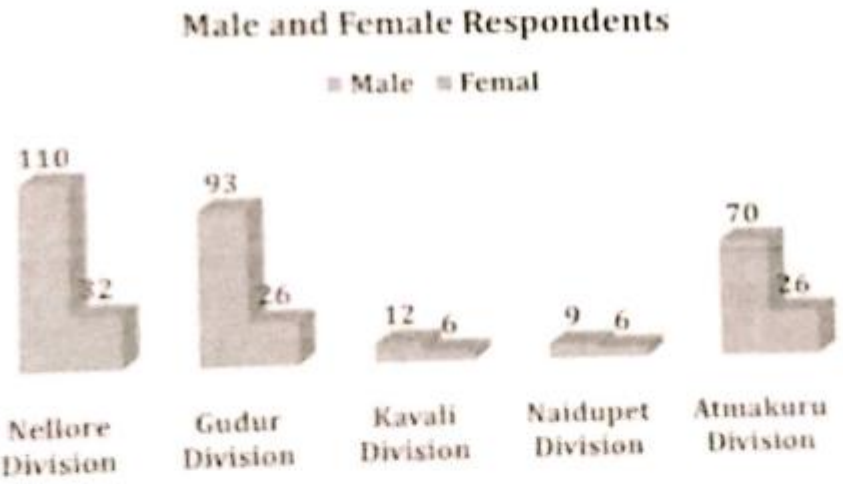

Fig: 2 Male and Female the Respondents in the Nellore District

Age certainly plays an important role that is considerable manufacturing together with total output. if a person is younger, the manufacturing output will be more. The production could be different if the weavers are young. Therefore, the significance of age influences the manufacturing output and it will affect overall income. The age of the respondents and their respective percentages are presented in Table 3.

Table 3 depicts the division-wise distribution of Respondents by Age Group during the year 2018-19 In the Nellore division, out of 142 respondents, 47.9 percent respondents are in the age group above 60 years, 47.2 percent of respondents are in the age group of 26-45 years, 4.9 percent respondents are in the age group of up to 25 years. In the Gudur division, out of 119 respondents, 29.4 percent of respondents are in the age group above 60 years, 69.7 percent of respondents are in the age group of 26-45 years, and 0.8 percent respondents are in the age group of up to 25 years. In the Kavali division, out of 18 respondents, 27.8 percent of respondents are in the age group above 60 years, 61.1 percent of respondents are in the age group of 26-45 years, and 11.1 percent respondents are in the age group of up to 25 years. In the Naidupet division, out of 15 respondents, 26.7 percent of respondents are in the age group above 60 years, 60 percent of respondents are in the age group of 26-45 years, and 13.3 percent of respondents are in the age group of up to 25 years. On the other hand out of 96 respondents in Atmakuru division, 46.9 percent of respondents are in the age group of above 60 years, 39.6 percent of respondents are in the age group of 26 45 years, 13.5 percent of respondents are in the age group of up to 25 years.

Table 3

Division-wise Distribution of Respondents by Age Group in the year 2018-19

Revenue division	Age Groups			Total
	Up to 25 years	26-45 years	46-60 years	
Nellore	7 (4.9)	67 (47.2)	68 (47.9)	142 (100.0)
Gudur	1 (0.8)	83 (69.7)	35 (29.4)	119 (100.0)
Kavali	2 (11.1)	11 (61.1)	5 (27.8)	18 (100.0)
Naidupet	2 (13.3)	9 (60.0)	4 (26.7)	15 (100.0)
Atmakuru	13 (13.5)	38 (39.6)	45 (46.9)	96 (100.0)
Total	**25 (6.4)**	**208 (53.3)**	**157 (40.3)**	**390 (100.0)**

Source: Field Survey

Note: Figures in the bracket are the percentage of the respondents

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3567.6	2	1783.8	2.8699	0.0958	3.8853
Within Groups	7458.4	12	621.5333			
Total	11026	14				

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Taken from table 4 an ANOVA results in the calculated value of F is 2.8699. The table value of F at a 5% level of significance for (2,12) degree of freedom is 3.8699. As the calculated value is less than the table value, we accept the null hypothesis. It can conclude that there is no significant difference in the Distribution of Respondents by Age Group of handloom weavers.

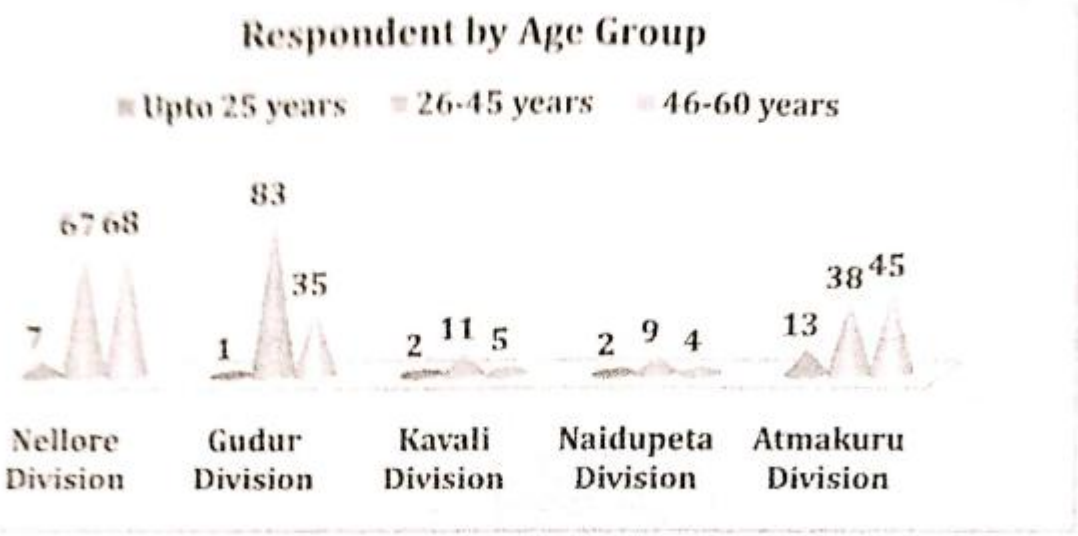

Fig: 3 Division-wise distribution of Respondents by Age Group

The growth of the handloom industry varies according to the education with skills of the weaver to a certain level. An educated weaver with skill understands better the Government support and also knows the market situation and thereby alters production strategy to suit the needs that are changing requirements of customers.

Information in respect of the educational status of the respondents in five divisions is presented in Table 4. In Nellore division, 14.8 percent of respondents are illiterate, 24.6 percent of respondents have primary education, 23.9 percent of respondents have secondary level education, 22.5 percent of respondents have intermediate level education and only 14.1 percent of respondents have graduate-level educationout of total 142 respondents. Out of 119 respondents, 18.5 percent of respondents are illiterate, 19.3 percent of respondents have primary education, 23.5 percent of respondents have secondary level education, 21 percent of respondents have intermediate level education and only 17.6 percent of respondents have graduate-level education in the Gudur division.

In the Kavali division, 33.3 percent of respondents are illiterate, 50 percent of respondents have primary education, 5.6 percent of respondents have secondary level education, 5.6 percent of respondents have intermediate level education and only 5.6 percent of respondents have graduate-level educationout of total18 respondents.

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Table 4

Division-wise Distribution of Respondents by Education during the year 2018-19

Revenue Division	Education Groups					Total
	Illiterate	Primary	Secondary	Intermediate	Degree	
Nellore	21 (14.8)	35 (24.6)	34 (23.9)	32 (22.5)	20 (14.1)	142 (100.0)
Gudur	22 (18.5)	23 (19.3)	28 (23.5)	25 (21.0)	21 (17.6)	119 (100.0)
Kavali	6 (33.3)	9 (50.0)	1 (5.6)	1 (5.6)	1 (5.6)	18 (100.0)
Naidupeta	9 (60.0)	1 (6.7)	1 (6.7)	1 (6.7)	3 (20.0)	15 (100.0)
Atmakuru	32 (33.3)	12 (12.5)	20 (20.8)	25 (26.0)	7 (7.3)	96 (100.0)
Total	**90 (23.1)**	**80 (20.5)**	**84 (21.5)**	**84 (21.5)**	**52 (13.3)**	**390 100.0)**

Source: Field Survey

Note: Figures in the bracket are a percentage of the respondents

In the Naidupeta division, 60 percent of respondents are illiterate, 6.7 percent of respondents have primary education, 6.7 percent of respondents have secondary level education, 6.7 percent of respondents have intermediate level education and only 20 percent of respondents have graduate-level educationout of total 15 respondents. On the other hand, 33.3 percent of respondents are illiterate, 12.5 percent of respondents have primary education, 20.8 percent of respondents have secondary level education, 26 percent of respondents have intermediate level education and only 7.3 percent of respondents have graduate-level educationout of total 96 respondents in the Atmakuru division.

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	179.2	4	44.8	**0.2715**	0.8929	**2.8661**
Within Groups	3300.8	20	165.04			
Total	3480	24				

Taken from table 4,an ANOVA results in the calculated value of F being **0.2715.** The table value of F at a 5% level of significance for (4.20) degree of freedom is **2.8661.** As the calculated value is less than the table value, we accept the null hypothesis. It can conclude that there is no significant difference in the Distribution of Respondents by Education of handloom weavers.

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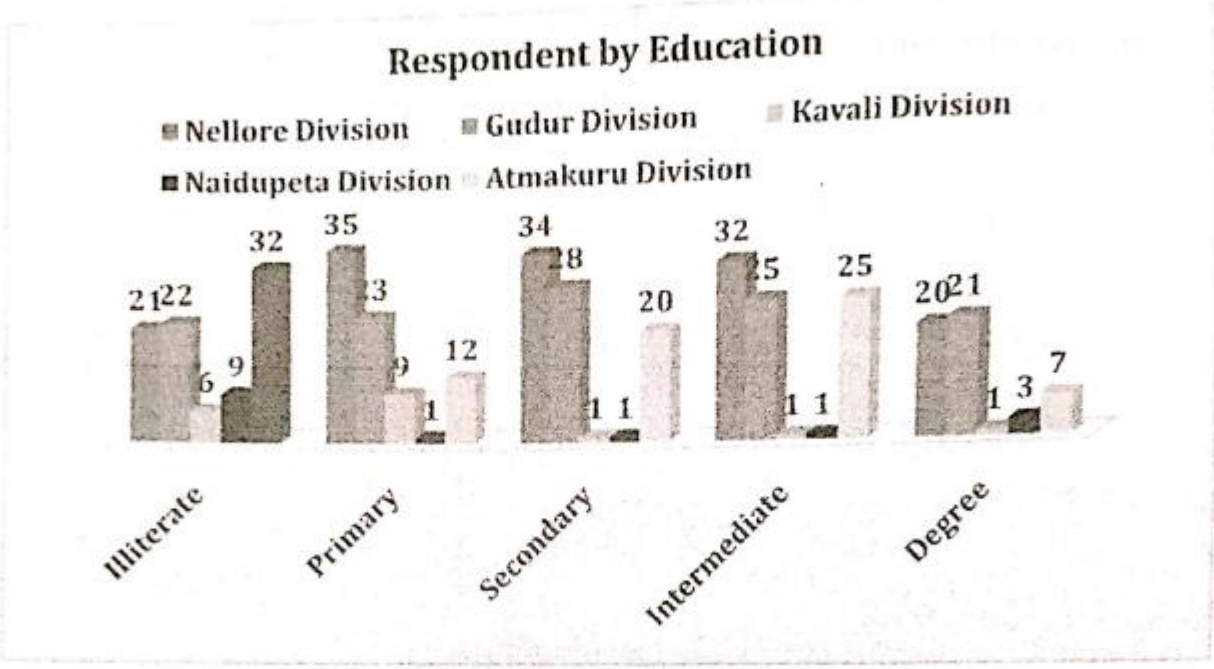

Fig 4:Division-wise Distribution of Respondents by Education

The predominance of certain communities within a tradition is certainly a specific occupation that is neither insignificant nor ignorable. In several areas, weavers have emerged from particular courses which can be socio-economic. The underdeveloped areas have never yet achieved that stage of development if they can afford to discount the known fact that the handloom industry flourished naturally in some communities. In India, some communities seem to have a tendency that is strong handloom activity. Several scientific studies were undertaken during the periods this is certainly local to the predominance of certain communities among the weaving classes. In the SPSR Nellore district, 100 percent of the respondents belonged to Backward Caste (BC). Table 5 reveals that the social group of weaver's households in five divisions as follows:

In the Nellore district, five social groups are engaged in handloom weaving activities. Out of 142 respondents in the Nellore division 52.1 percent of respondents belong to the Devanga community, 42.3 percent of respondents are Padmasali, 5.6 percent of respondents are Kaikala and nobody is found from Pattusali and Thogota communities. Out of 119 respondents in the Gudur division 19.3 percent of respondents belong to the Devanga community, 23.5 percent of respondents are Padmasali, 21.8 percent of respondents are Kaikala, 17.6 percent from Pattusali, and 17.6 from the Thogota community. Out of 18 respondents in the Kavali division 66.7 percent of respondents belong to the Devanga community, 22.2 percent of respondents are Padmasali, 11.1 percent of respondents are Pattusali and nobody is found from Kaikala and Thogota communities.

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Table 5

Division-wise Distribution of respondents by Social Group during the year 2016-17

Revenue Division	Social Group					
	Devanga	Kaikala	Padmasali	Pattusali	Thogata	Total
Nellore	74 (52.1)	8 (5.6)	60 (42.3)	0 (0.0)	0 (0.0)	142 (100.0)
Gudur	23 (19.3)	26 (21.8)	28 (23.5)	21 (17.6)	21 (17.6)	119 (100.0)
Kavali	12 (66.7)	0 (0.0)	4 (22.2)	2 (11.1)	0 (0.0)	18 (100.0)
Naidupeta	6 (40.0)	1 (6.7)	6 (40.0)	2 (13.3)	0 (0.0)	15 (100.0)
Atmakuru	0 (0.0)	0 (0.0)	10 (10.4)	27 (28.1)	59 (61.5)	96 (100.0)
Total	**115 (29.5)**	**35 (9.0)**	**108 (27.7)**	**52 (13.3)**	**80 (20.5)**	**390 (100.0)**

Source: Field Survey

Note: Figures in the bracket are the percentage of the respondents

Out of 15 respondents in the Naidupeta division 40 percent of respondents belong to the Devanga community, 40 percent of respondents are Padmasali, 6.7 percent of respondents are Kaikala, 13.3 percent of respondents are Pattusali and nobody is found from the Thogata community. On the other hand, in the Atmakur division out of 96 respondents are engaging in handloom weaving activity. Among the five social groups 10.4 percent of respondents belong to the Padmasali community, 28.1 percent of respondents are Pattusali, 61.5 percent of respondents are Thogota and nobody is found from Devanga and Kaikala community.

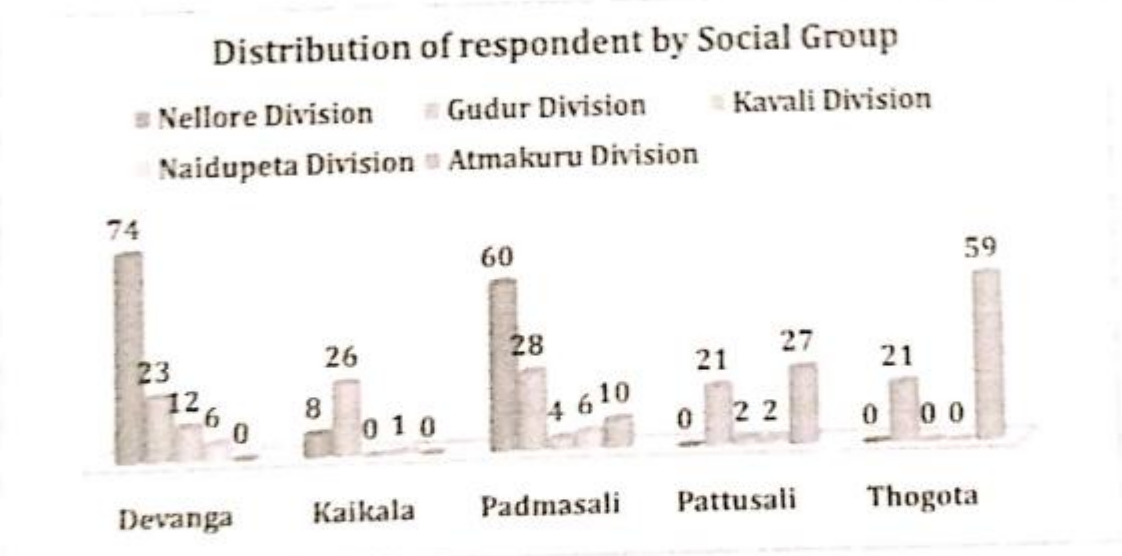

Fig 5: Division wise Distribution of respondents by Social Group

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At present a ration card is the indication of the status of the income of the people and ration cards are given by the government based on the socio-economic levelsof the people

Table 6 shows the status of ration cards of respondents in the district. In the Nellore division, it is clear that almost 68.3 percent of the respondents own BPL (Below Poverty Line) cards and 31.7 percent of respondents are living without ration cards.

Table 6

Division-wise Distribution of Respondent by Ration Card during the year 2018-19

Revenue Division	Type of Ration Card		Total
	BPL Card	NO	
Nellore	97 (68.3)	45 (31.7)	142 (100.0)
Gudur	68 (57.1)	51 (42.9)	119 (100.0)
Kavali	17 (94.4)	1 (5.6)	18 (100.0)
Naidupeta	13 (86.7)	2 (13.3)	15 (100.0)
Atmakuru	82 (85.4)	14 (14.6)	96 (100.0)
Total	**277 (71.0)**	**113 (29.0)**	**390 (100.0)**

Source: Field Survey

Note: Figures in the bracket are the percentage of the respondents

In the Gudur division, it is clear that almost 57.1 percent of the respondents own BPL cards and 42.9 percent of respondents are living without ration cards. In the Kavali division, it is clear that almost 94.4 percent of the respondents own BPL cards and 5.6 percent of respondents are living without ration cards. In the Naidupeta division, it is clear that almost 86.7 percent of the respondents own BPL cards and 13.3 percent of respondents are living without ration cards. On the other hand, in the Atmakuru division, it is clear that almost 85.4 percent of the respondents own BPL cards and 14.6 percent of respondents are living without ration cards.

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	2689.6	1	2689.6	**2.6426**	0.142689	**5.3177**
Within Groups	8142.4	8	1017.8			
Total	10832	9				

Taken from table 6,an ANOVA results in the calculated value of F is **2.6426.** The table value of F at a 5% level of significance for (1.8) degree of freedom is **5.3177**. As the calculated value is less than the table value, we accept the null hypothesis. It can conclude

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that there is no significant difference in the Distribution of Respondent by Ration Cards of handloom weavers.

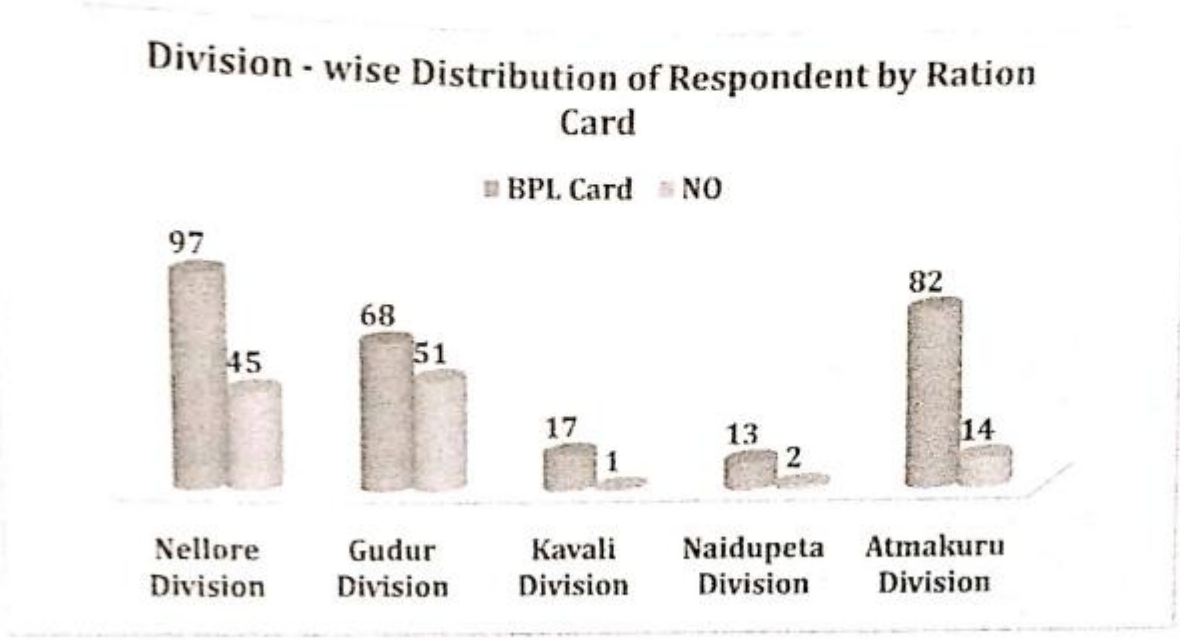

Fig 6 Division-wise Distribution of Respondents by Ration Card

CONCLUSIONS

It is concluded that the handloom sector has a unique place in the Indian economy and plays a vital role in the economic development of the rural poor. It is one of the largest economic activities providing direct employment to over 35 lakhs persons engaged in weaving and more than 72 percent are women in it.The majority of them are low caste and extremely poor, working in small family households. This sector contributes nearly 19 percent of the total production of the cloth produced in the country and also adds substantially to the export earnings. The handloom industry is gradually declining over the years and the handloom weavers are facing serious problems due to a severe livelihood crisis. The main reasons behind this are unsystematic government policies, globalization, competition from power looms and mills, ineffective implementation of schemes, and changes in social and economic conditions and factors. It is suggested that the government should develop a user friendly and skill development training programmes, provide low cost machines which will make the weaving process more efficient, promotion of market linkage, provide working capital loans from banks and other financial institutions, and provide technical assistance to create designs for development of weavers. Encourage and support to

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participate in trade fairs which will promote their products. If these suggestions are taken into consideration,it can solve the handloom weavers' problems to a great extent in SPSR Nellore District.

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