CHAPTER 1

Review of Literature & Hypotheses and Objectives
“Sleep is a good chain of health and bodies”.
—Dale Carnegie

1.1. Introduction

Our life is influenced and governed by three most special clocks i.e. the solar clock (alternation between day and night), the societal clock and the endogenous biological clock (Roenneberg et al., 2003). The interactions among these three clocks outcome in rhythmic behaviors are called biological rhythms.

Biological rhythms are classified into mainly three categories i.e. Ultradian (τ < 20 h), Circadian (20 h > τ < 28 h) and Infradian (τ < 28 h) rhythms. Among these rhythms, circadian rhythm which is endogenously generated rhythm and exhibits a periodicity that corresponds to day-night cycle (Pati, 2001). The temperature cycle, the alternation between sleep and wakefulness, the heart rate rhythm and the blood pressure rhythm are most evident variables of such rhythms. A thorough study of the bodily functions involving many overt behavioral, physiological and biochemical processes, allows a description of several circadian rhythms within the different body systems. It can thus be stated that the fundamental nature of living matter lies in rhythmicity. These rhythms ascertain temporal relations or phase relations with external environment and constitute the so-called internal temporal order. Circadian variations in temperature and plasma cortisol rhythm are excellent examples of such type of temporal order. It has been observed that after the commencement of night, prior to people fall asleep, their plasma melatonin levels increase. While before sunrise the body prepares for wakefulness when the plasma cortisol levels increases. Likewise during early morning hours the body temperature drops to its minimum, and attain its peak in the early evening. Most interestingly, it has been observed that cultures of nerve cells, liver and lung tissues exhibited self-sustained circadian oscillations, showing that tissues have molecular clocks that have an ability of generating and sustaining circadian oscillations (Pati, 2001).

Under the natural conditions, circadian rhythms with a period of approximately equal to 24 hours in various physiological, biochemicals, immunological, behavioral and psychological functions have been known for a long time in man (Reinberg et al., 1980). There are however, several forceful situations that lead to variation of the period from 24 h and disrupt temporal organization. Jet
lag and shift work are the best known examples of such situations (Aschoff et al., 1975).

Primarily circadian rhythms were supposed to be a passive response to the natural day-night cycle. However, now it has been clearly understood that these circadian rhythms are endogenous and self-sustained oscillations as noticed in the constant conditions, where all possible environmental cues (Zeitgeber) were excluded.

The biological clock mechanism present in the hypothalamus controls the expression of such rhythms by incorporating the nervous system and participates essentially in the regulation of so called circadian timing system. Recent studies stated that the hypothalamic suprachiasmatic nuclei, considered not only as master clock but also establishes different levels of synchronization within our bodies (Yoo et al., 2004). Thus SCN has two important functions. (1) It maintains the homeostasis for some physiological function like, body temperature; and (2) it also initiates specific function like, onset of melatonin secretion (Klerman, 2005).

The primary function of the circadian system is to organize and synchronize the cellular and behavioral variables of organisms with the outside world. According to Aschoff (1960), internal synchronization is the timely coordination of multiple individual oscillators, devoid of an external Zeitgeber. Based on the above conception, regulation of the organism’s temporal order depends on two basic processes: the synchronizing effect of external Zeitgebers through a process called entrainment, and the internal synchronization. Entrainment depends on a several events; the first step is the perception of light by the retinal ganglion cells and information reaches to the central nervous system which then coordinates entrainment, by activation of the internal synchronization process. In order to activate this process, the central nervous system uses various output stimuli to spread the circadian information all over the body (Brandstaetter, 2004). This mechanism involves direct and indirect neuronal projection pathways and discharge of polypeptides (Albrecht, 2004). The endogenous entrainment mechanism is governed by multiple feedback regulatory mechanisms, ensuing in a coordinated rhythmicity of the organism’s physiology and behavior. Alterations in the internal temporal order are coupled with several diseases (Knutsson, 2003). The endogenous circadian oscillator is slow to adjust to altered rest-activity patterns. Time-zone transitions and shift work
are conditions that cause significant negative consequences to humans, due to the slow adjustment of the body clock. (Bos et al., 2003).

As, the human circadian system has an endogenous period slightly longer than 24h, it tends to fluctuate later and later each day (Burgess et al., 2002). Phase delays therefore occur more readily than phase advances in the human species. Looking deep into the mechanisms involving synchronization processes allows understanding their flexibility and limitations.

Being diurnal in nature, human beings are more active during the daytime than that of the nighttimes (Pati, 2001). Although, there are noticeable individual differences in preferences for sleep and wakefulness schedules, in the human species night and sleep are events that supposed to happen simultaneously all the time. Several studies have attempted to investigate the biological mechanism underlying individual differences comprising the circadian timing system (Horne and Östberg, 1976; Smith et al., 1989; Torsval and Åkerstedt, 1980). One of the most significant finding is establishment of the term chronotype (Horne and Östberg, 1976).

1.2. Shift Work

Shift work research is one of the applied areas studied under the domain of Chronobiology. “The term shift work is defined as an arrangement of working hours that uses two or more teams (shifts) of workers in order to extend the hours of operation of the work environment, beyond that of the conventional office hours” (Knutsson, 1989).

Workers employed in manufacturing industries or other service sectors are required to work on irregular working hours, including night and early morning work to provide uninterrupted 24 h services. Shift work schedules can differ from one workplace to another characterized by either rotating shift work in a clockwise or counterclockwise direction or permanent night work or on call shift duty (Pati, 2001, 2004; Pati et al., 2001; Borges and Fischer, 2003; Pease and Raether, 2003; Pati and Parganiha, 2006). Working hour for Each particular shift may be for 8-h or 12-h duration for 6 consecutive days. The rotating shift system is a three shift system including night shift, afternoon shift and morning shift. In various sectors night, afternoon and morning shift were mainly known as first shift second shift and third
shift. The workers take one or two days rest after each shift. In some organizations rotational shift system may not be strictly followed and become irregular due to mutual setting among the shift workers. This system is most popular in emergency sectors, defense, industries etc. Some workers performed only night shift therefore called as permanent night workers (Wilkinson, 1992; Fischer et al., 2000; Borges and Fischer, 2003). The night shift may either start early in the evening hours till late night or start late night and lasts for early morning hours. Permanent night systems are performed by night guards and workers of news paper manufacturing industries etc., On-call shift is a special work system of shift in which workers are called during emergency (Aguirre and Foret, 1994). This system is totally irregular, and have no time or day limitations.

Further, working shifts may be beneficial for some people partly because of the financial incentive usually associated with working unusual hours, and partly because the hours of work often facilitate domestic arrangements. However, for many individuals shift work is not seen as beneficial, and the various problems that this may cause are a topic of major concern. Workers either on permanent night schedule or on schedules that keep on rotating at specified time intervals usually accomplish work in the night. Thus, shift work is a necessity for continuous operation of various essential sectors and emergency services.

1.3. Consequences of Shift Work

The major problems of the shift work are thought to result from the fact that *Homo sapiens* have been evolved as a diurnal species who habitually sleep at night and stay awake or work during the day; therefore, engaging in shift work is believed to result in a mismatch between our internal bodily rhythms and the external time cues that entrain the circadian rhythms. This may therefore result in the sleep of the shift worker being shifted to a time of day that is not appropriate for sleep (Åkerstedt and Gillberg, 1981).

There is substantial research literature in this area that has identified a wide range of problems that individuals may experience as a result of working on shifts. These range from acute disturbances of circadian rhythms and sleep to a chronic impairment of behavioral, mental and physical health (Waterhouse et al., 1992). In
addition, shift work causes adverse effect that may eventually interfere with the sleep, performance and job satisfaction (Dijk et al., 1992; Shield, 2002; Demerouti et al., 2004).

1.4. Shift Work and Rhythm Disruption

Shift workers often experience external and/or internal desynchronization of biological rhythms (Reinberg et al., 1984; Gupta and Pati, 1994a; Pati and Saini, 1991). Many shift work researchers would argue that some types of shift systems, or features of shift systems, are likely to be more disruptive than others, and thus have more of a detrimental effect on the individuals concerned. This has resulted in much research which has aimed at identifying those systems or features of systems which are believed to be more healthy and safe than others. However, there appears to be no ideal shift system. Much attention has been based on trying to identify the most problematic features of different shift systems, with considerable progress having been made (Czeisler et al., 1982; Knauth, 1993) and in developing scales that may identify individuals who are more likely to be able to tolerate shift work (Smith et al., 1989). Barton and Folkard (1993) in a group of industrial workers reported the implications of the duration of shift rotation on the health and well being of the individuals concerned. Delaying systems were found to have the least detrimental effect, whilst advancing systems which included a quick return from one type of shift to another were found to be more suitable. According to Kogi (1985), night workers exhibited 9 or 10 h phase delay of their diurnal rhythms rather then a complete 12-h inversion. Changing from day to night work has been found to be associated by a disruption of circadian rhythmicity, by an increase of serum lipids, glucose, and uric acid, with elevation of urinary excretion of catecholamine (Theorell and Akerstedt, 1976).

Moreover, inversion of the work schedule causes an alteration in the phase relationships among the internal rhythms. This change occurs subsequently to an abrupt change in the external time cues. This is precisely happens in case of night workers or shift workers where, an alteration takes place in the temporal organization which is responsible for the entrainment of biological rhythms. The result is desynchronization of the internal temporal order, as it is evident that the resynchronization of the circadian rhythms with that of the external environment does
not occur at the same speed. Thus, existence of the inter-individual differences between individuals in such desynchronization and the subsequent resynchronization of the internal temporal order become relatively apparent. Thus, for the morning active chronotype, remaining alert during night shifts is more difficult than for the evening active chronotype.

1.5. Sleep

Each night, the human body needs a definite amount of sleep to function effectively. The average amount of sleep a person needs is 7-8 hours. When the number of hours during night is reduced a state called 'sleep debt' is accumulated. Sleep debt can be defined as the difference between the hours of sleep needed by the person and the hours of sleep that is actually experienced by the person. Lamond et al. (2003) documented that shift workers experience on an average sleep debt of 3.53 hours per week of night shift. There is enough evidence to show that sleep debt in shift workers could be attributed to poor quality and quantity of sleep (Hak, 1981).

Sleep problems among shift workers has been raised as an important issue by the Chronobiologists. Voluminous earlier literature addressing this subject document sleep characteristics in shift work condition such as timing, duration, quality and structure of the main sleep, frequency and duration of naps, as well as their relationships (Åkerstedt, 1984; Brown, 1990; Douchon and Karen, 1990; Folkard and Barton, 1993; Knauth et al., 1980; Kogi, 1982; Maasen et al., 1980; Oginska and Oginski, 1990; Radošević-Vidaček et al., 1991; Tepas, 1982; Tepas and Carvalhais, 1990; Tepas and Mahan, 1989; Tepas et al., 1993). In another previous study it was observed that shift workers with higher sleep need slept somewhat more in connection with the night and morning shifts (Sallinen et al., 2003). Poor sleep quantity and quality have been thought as an important factor influencing the performance of shift workers during the night shift (Pati, 2001; Son et al., 2008). It has also been reported that sleep deprivation along with desynchronized rhythms lead to impaired physical performances (Smolensky et al., 1985). Further, sleep disturbances are also caused by disruption of circadian rhythms as some sleep parameters, such as the duration and sleep structural design, are regulated by the biological clock (Dijk and Czeisler, 1995). Consequently, shift workers and night workers are vulnerable to difficulties in sleeping deeply, for an adequate period of time (Åkerstedt, 1998; Ingre et al., 2004;
Nakata et al., 2004; Portela et al., 2004; Santos et al., 2004). Thus, it has clear that significant reduction of diurnal sleep occurs due to a circadian effect i.e. in most studies the duration of diurnal sleep depends on the time of the day in which it takes place (Czeisler et al., 1980). Further, it has been suggested that the distinctive features of the work environment would act as time cues to advantage circadian adjustment (Parkes, 1993).

1.6. Characteristics of Sleep in Day Workers and Shift Workers

Shift workers always complain about the problem of sleep loss as compared to day workers (Åkerstedt, 1998). Many authors have reported that sleep length for shift and night workers becomes shorter than that of day workers. Studies conducted the sleep length estimates vary greatly from study to study but usually range from 4 h to 6 h for those on shift workers performing night work, as compared to the 7-9 h for that working day or afternoon work (Åkerstedt and Torsvall, 1981; Knauth et al., 1980; Quaas, 1969; Sprusinska and Pawlowska-Skyba, 1976). Most of the studies have shown that individual working on shift system experienced disturbed sleep and excessive daytime sleepiness as compared to day work (Åkerstedt et al., 2002; Ohayon et al., 2002; Åkerstedt, 1988; Åkerstedt, 2003; Pilcher and Coplen, 2000; Richardson et al., 1989, Åkerstedt et al., 2008; Son et al., 2008). In a recent study, the sleep analysis of truck drivers revealed significant differences between truck drivers working under irregular schedules and those working only during day time that demonstrates the influence of the work schedule upon the sleep of the individual (Moreno et al., 2003). In general, shift workers report more sleep problems than day workers (Åkerstedt, 1998). Sleep researchers observed that diurnal sleep consisted of some structural differences in the duration of the diurnal sleep phases as compared to nocturnal sleep (Åkerstedt, 1995 a,b). The outcome of this sleep decline leads to chronic sleep deprivation characteristically observed in rotational shift and night shift workers. While evening shift workers adopt a schedule that requires a 2 h or 3 h phase delay in their bedtime and usually get more sleep than their day working counterparts (Tepas, 1982).
1.7. Impact of Three Shifts on Sleep

Of the health related problems, disturbed sleep is one of the most obvious and prominent problems related to shift work (Åkerstedt, 2003). Shift workers always report more sleep disturbances than day workers (Åkerstedt, 1998). The effects vary, however depending upon the shift timings. The impact of night, morning and afternoon shifts on sleep patterns is summarized below.

1.8. Night Shift

The night sleep before the first night shift is long, starts early and lasts for 8:00-h (Knauth and Rutenfranz, 1981). It is frequently associated with napping in the afternoon (Åkerstedt, 2003). Day sleep after night shift was short, and involuntary sleep occurs in the time during the night shift and the shortened day sleep is compensated for through an afternoon nap (Åkerstedt, 2003). Further, based on a subjective diary study, the night shift is characterized by increased severe sleepiness (Härmä et al., 2002). Recently it has been discovered that night shift workers experience chronic sleep debt, reduced sleep efficiency, and reduced total sleep time as compared to day workers (Wilkinson, 1992; Drake et al., 2001; Dongen et al., 2003). However, sleep length was found to be more in permanent night workers as compared to rotating shift workers. A study conducted in shift working bus drivers revealed that their sleep during the day was shorter and more fragmented than at night (Santos et al., 2004). Further it has been pointed out that the ability to sleep in the daytime following a night shift decreases with increasing age (Åkerstedt and Torsvall, 1981). Numerous authors documented insomnia, sleep deprivation, impaired sleep quality, daytime sleepiness and reduced alertness in night shift workers (Frese and Harwich, 1984; Härmä et al., 1998; Lowden et al., 1998; Khaleque, 1999). In particular, during periods of night work, the duration as well as the structure of daytime sleep has been shown to be adversely affected by the shifted timing of the sleep period (Åkerstedt and Torsvall, 1981; Kerkhof and Lancei, 1991). Relative to nocturnal sleep, the duration of diurnal sleep appears to be reduced, with most of this sleep loss being stage two and REM sleep (Åkerstedt et al., 1991). According to Tepas and Carvalhais (1990) permanent night shift workers sleep longer on their days off, but they still sleep almost 4 hours less per week than the day workers do. Mostly continuous after post night work sleep is associated with feelings of not being fully
rested. Therefore sleep after night shift becomes very short due to inability to maintain sleep rather than to difficulties in falling asleep. Other studies have also suggested that sleep during the daytime is restless and difficult to sustain, particularly before noon, because the core temperature increases during the morning (Czeisler et al., 1980; Waterhouse et al., 1992, 2001). As a result, night workers usually acknowledged sleep disturbances (Åkerstedt, 1984; Gander et al., 1998). Further, it has been observed that the decrease in the waking threshold during night work was usually associated with decreased levels of alertness, increased levels of fatigue, and deteriorations in performance (Åkerstedt and Folkard, 1997; Samel et al., 1995; Waterhouse et al., 1992).

In train drivers, the prevalence of early morning shifts was higher than the total number of shifts (Ingre et al., 2000; Hak and Kampman, 1981; Härmä et al., 2002). Despite the high sleepiness occurrence of early morning shift in shift workers little is known about sleepiness and variation in sleep. The hazardous impact of morning work is mainly concerned with reduced sleep prior to early morning shift. This has been investigated among drivers on the highways, who often suffers from sleep loss due to increase in early driving (Philip et al., 1999, 2002). Further, the study of Ingre et al. (2004) showed that in truck drivers the sleep length was reduced for the early shift by 1 h and 2 h, respectively, as compared to the day and evening shift. Also, the prevalence of sleepiness was considerably higher in early shift during their driving (Ingre et al., 2004).

1.9. Morning Shift

The sleep pattern before a morning shift appears to be even more disturbed compared with night shift (Folkard and Barton, 1993). The short sleep has been confirmed in EEG studies where stage 2 and REM are affected (Åkerstedt, 1995). The main subjective effect is difficulty with awakening, non-spontaneous awakening and feeling of not being refreshed by sleep (Åkerstedt et al., 1991). Early times of arising are also strongly associated with increased sleepiness during the rest of the day (Kecklund and Åkerstedt, 1993). In other study, it has been reported by in that, early morning shifts increased the anxiety stress before sleep, reduced sleep length, and increased sleepiness propensity among train drivers (Kecklund et al., 1997).
1.10. Afternoon Shift

Compared to morning and night shifts, very little studies have been investigated the impact of afternoon shifts on sleep. Usually afternoon shift is characterized by patterns of slightly late bedtimes with an absence of napping (Knauth and Rutenfranz, 1981; Åkerstedt and Kecklund, 1991; Tepas, 1982).

1.11. Sleep Length

A previous study also suggests that sleep problems not only occur mainly in night work but also to some extent in morning work (Åkerstedt, 1984). In general, it has been reported that workers on the afternoon/evening shifts sleep the longest, workers on the day shift sleep slightly less, and night shift workers sleep the least (Åkerstedt and Torsvall, 1981; Tepas and Carvalhais, 1990).

Furthermore, Kawada and Suzuki (2002) reported that sleep length is affected by rotating shift work. In recent years, the negative impact of offshore shift work on worker’s sleep, health and safety has increased the interest in this area of researchers (Forbes, 1997; Miles, 2001; Parkes, 1993; Parkes and Swash, 2000; Parkes et al., 1997). In these studies sleep loss and poor sleep have been a salient finding among offshore shift/night workers. There are number of follow-up studies (after 18 months, 3 years, 5 years, 7 years and 8 years) of sleep in shift workers involving reexamination of shift workers during rotating shift system, same shift system and irregular working hours (Radošević-Vidaček et al., 1995; Åkerstedt and Torsvall 1978, 1985; Tepas et al., 1984; Kundi et al., 1986; Verhaegen et al., 1987; de Vries and de Vries-Griever, 1990). The study of Radošević-Vidaček et al. (1991) suggest that young shift workers take more nap to compensate their sleep dept on the morning shift days than on the night shift days following their sleep for 5 years. However, they claimed that reduced sleeps on morning and night shift days were not compensated by taking nap but rather with an increase in main sleep duration on afternoon shift days and days off. In an earlier study on women working at night under a fixed schedule suggested that a relationship existed between the sleep need and fragmented sleep (Moreno et al., 2000).

Although, there are extensive data representing the impact of shift work on
sleep and alertness, little attention has been paid to the prevalence and consequences of shift work related sleep disorder as compared to the difficulties with insomnia and excessive daytime sleepiness experienced by day workers (Drake et al., 2004). Drake et al. (2004) reported that about 10% of night and rotating shift work population suffers from sleep disorders. While handling with shift and night workers, keen interest should be paid towards sleep disorders, sleep-related complaints and excessive daytime sleepiness. Since these factors greatly influences coping ability to shift and night work. As obvious, sleep disorders occurred from disruption in the diurnal nature of the human species, which does not allow body to adapt with the inversion of the sleep and wakefulness periods. Further, in previous studies it has been observed that few sleep characteristics, individual factors and sleepiness were the strong predictor of dissatisfaction with the shift schedule (Iskra-Golec, 1993; Kecklund et al., 2000). In another study on satisfied and dissatisfied individual a multiple logistic regression analysis of the major predictor of satisfaction with their work hours was used (Axelsson et al., 2004). Their results showed that general sleep quality and global anxiety/ depression symptoms were the major determinants among the large set of predictors (age, gender, marriage, BMI, diurnal type, sleep flexibility, health problems, sufficient time for social interaction).

Smith et al. (1999) documented that various individual and situational variables influence sleep and social/domestic set up of shift workers. They further reported that sleep disturbances cause increased emotional problems and somatic anxiety in permanent night shift workers. Inter-individual differences in sleep disturbances as a result of shift work are well recognized (Åkerstedt and Torsvall, 1981; Kerkhof and Lancel, 1991) and are believed to be related to long-term shift-work tolerance (Costa, 1997). Limited research has focused on the predictors of these individual differences (Härmä, 1995). In addition to shift work, work stress and physical workload also affect the sleep profile of a worker (Åkerstedt et al., 2002).

According to Carskadon et al. (1982) elderly persons with normal lifestyle found difficulty to remain wakeful during the daytime due to strong feeling of sleepiness. One more additional reason contributing to this sleep deterioration could be irregular working hours in elderly people. However, though shift work research in this area often depicts increased difficulties of adjustment with advancing age, very
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few studies have focused on this issue.

Further, there was little previous research on the difference of sleep between the genders, and the results of their researches were not in accordance with each other. Tune (1969) showed that there was no difference in sleep parameters by gender.

1.12. Medical complications

According to Costa (2003), majority of night workers complain about several gastric disorders, characterized by appetite and digestive disorders, heartburn, abdominal pains, constipation, borborygmus, and flatulence to more serious diseases such as chronic gastritis, gastroduodenitis, peptic ulcer, and colitis. Shift work is associated with an increased stress on the worker with both psychological and physical consequences. A number of studies have identified development of sleep disturbances, fatigue, tiredness, performance decrements, and psychological disturbances, ischemic heart diseases, peptic ulcers, reproductive hazards, hypertension lipid intolerance (evidenced by increased triacylglycerol concentrations), an increase in late-onset diabetes, as well as cardiovascular and gastrointestinal complications to be the prominent health problems among shift workers (Costa, 1996, 2003; Pati et al., 2001; Morgan et al., 1999). The impact of shiftwork was particularly evident for reporting of chronic fatigue, and symptoms of cardiovascular and digestive disorders. Previous study (Barton et al., 1993) on a large group of nurses and midwives highlighted the importance of flexible as opposed to irregular shift system, particularly in relation to feelings of chronic fatigue and sleep difficulties for rotating shift nurses. In contrast the flexibility of the shift system was not found to impact differentially on the reported health and well being of nurses working on permanent night shift systems.

Further, obesity, a risk factor for both OSA and cardiovascular disease is highly prevalent among some professional categories, usually shift workers. Young et al. (2002) observed that obesity is a significant independent risk factor for obstructive sleep apnea (OSA) or respiratory interruptions occurred during nighttime sleep. Such nighttime respiratory interruption leads to sleep fragmentation and probably results in excessive diurnal sleepiness.
Fatigue has also been reported as one of the major problems among shift workers (Dawson and Fletcher, 2001). Work stress and physical workload interferes with the normal process of sleep-wake cycle that eventually leads to fatigue in shift workers (Åkersdest et al., 2002). The rotational shift workers report more fatigue than their day working counterparts (Cruz et al., 2000). Shift work-related fatigue might have some relationship with sleep onset latency and subjective sleepiness (Dawson and Fletcher, 2001).

Although, shift work is advantageous for all those work places that operate around the clock, it demands several teams of workers to work at different unusual times in order to keep continuous production. These teams can either shift their time of work according to morning, afternoon and night rotations or work under a fixed night schedule. These shifting in work schedules or permanent night work can be factors contributing in occurrences of several chronic diseases, such as gastric, cardiovascular, and sleep disorders. It has been observed that gastric disorders are occurred due to changes in dietary habits as an outcome of the abnormal work schedule. The main cause of these clinical complications is the desynchronized circadian rhythms. Monk (1988) showed that disrupted circadian rhythms are the main cause of traumatic injuries and low longevity of shift workers. In a number of cross-sectional studies a range of personality and behavior characteristics were found to show relationship with the tolerance to shift work (Monk and Folkard, 1985; Härmä, 1993). Still it is unclear how these associations should be interpreted concerning whether shift workers with certain characteristics are less able to tolerate shift work, or whether intolerance to shift work changes an individual’s personality (Monk and Folkard, 1985). However, Kalitema et al. (1995) by investigating age as a contributing factor reported more health problems in the group of older workers and those with longer shift work experience, with higher scores of neuroticism, hard-driving and competitiveness, speed and impatience and rigidity of sleeping habits and lower scores on relaxedness, efficiency and vigorousness.

The detrimental effects of shift and night work are not experienced to the same degree by all workers. Kawachi et al. (1995) conducted a large-scale prospective cohort study and found a positive relationship between shift work and an increased risk of ischemic heart disease among female workers. Age, sex, chronotype, tolerance
ability, tobacco consumption, obesity, family and social status are some other factors that necessitate more in-depth research in order to establish the association between shift work and health issues (Boggild and Knutsson, 1999). For instance, in a sample of truck drivers working irregular shift schedules, there was a higher incidence in the number of smokers, hypertensive individuals, sedentary habits, inadequate dietary habits and overweight (Pasqua and Moreno, 2003; Korelitz et al., 1993; Häkkänen, 2000). This finding highlights risk factors for various cardiovascular diseases such as systemic arterial hypertension, hypercholesterolemia, and coronary disease and so on. In short, many shift and night workers showed symptoms of risk factors contributing cardiovascular diseases, that occurred within this shift worker group, as a result of working at unusual times which is highly alarming. In addition, based on the results of several studies, a significant association between shift work and coronary disease was established which is one of numerous risk factors involved for poor health among shift workers (Knutsson, 2003). Although, the connection between shift work and severe diseases such as cancer and diabetes has been investigated in few attempts, further long term research is mandatory to establish conclusive findings (Schernhammer et al., 2003; Knutsson, 2003). It seems that factors other than work schedule possibly will also support that night work is a risk factor for a series of diseases. However, several studies have demonstrated that inversion of the sleeping/waking cycle by night work as such can be considered as major risk factor. Morgan et al. (2003) have recommended that the time-dependent variations in postprandial responses can also be linked to the risk of several diseases among shift and night workers. The information that night workers do not report any symptoms of a disease before working night work indicates the importance of individual differences in adaptation or tolerance to changing shift work (Monk and Folkard, 1992). Inter-individuals different exists in the ways that worker reacts with the several factors that influences adaptation to a specified work schedule. Individual differences become most evident, while working in night work.
1.13. Social and Domestic Disruption

The regulation of synchronization between the solar, social, and biological clocks is maintained throughout the lifetime of a person who works during the day and takes rest at night. On contrary, night workers suffer from the desynchronization between their work schedule and family/social activities. Nonetheless, working at unusual times of the day, lead to a range of both social and domestic problems for many workers. It has been argued that shift workers give resignation from their jobs due to social interruptions instead of clinical reasons (Pati and Perganiha, 2006). Thus shift work is likely to disrupt the fabrics of our family and society (Newsy and Hood, 2004). According to Walker (1985), the displacement of the shift worker in time and space can result in domestic inconvenience for the individual and spouse, as well as other members of the family, to the extent that it could have detrimental effects on family relationships. The situation within the home may be very powerful in limiting the amount of sleep obtained, particularly if the shift worker also has the main role of homemaker. According to Monk and Folkard (1992), reduced time for sleep and social activities, as well as time for important parent activities such as attending school open days can often lead to feelings of irritability which tend to result in further family problems. Effects of social life can be particularly harmful, often resulting in impoverished social contacts and difficulty in pursuing interactive activities and hobbies such as joining clubs and societies. Because of the social expectation that people work during the weekdays and sleep at night, the majority of community activities occur during evenings and weekends, and this may cause the shift worker to experience feelings of disaffection from the community. In addition, shift workers tend to have fewer friends than day workers, and those they do have are often fellow shift workers (Walker, 1985). However, not all individuals engaged in shift work experience this disruption. Some prefer to pursue solitary lives and activities, and regard the higher financial reward and daytime leisure as more advantageous than a normal lifestyle.
1.14. Job Satisfaction

Shift work produces unfavorable effects on the job satisfaction (JS) of workers. A study predicts that the level of JS is statistically significantly more among permanent night workers as compared with those of the rotating shift workers Jamal (1981). Further it has been shown that the dissatisfied shift workers suffer from more sleep-wake problems than the satisfied shift workers (Axelsson et al., 2004). JS is extremely important especially because it reflects mental and physical well-being and contributes to overall life satisfaction (Locke, 1976; Mottaz, 1985). The extent of JS in an organization could be easily gauged from employee turnover (Mobley, 1977), productivity, absenteeism, and commitment (Locke, 1976; Mottaz, 1985).

1.15. Accidents and Injuries

Shift work related consequences have been put forward as an important factor contributing to accidents and incidents at work places. Sleep disturbances and accumulated sleep deprivation have been linked with increased accident risk (Åkerstedt, 1998; Folkard and Lombardi, 2004; Crummy et al., 2008). The combined effect of fatigue and sleepiness decreases alertness, which consequently increases the risk of human errors and accidents especially during night shifts in the transport sector (Lowden et al., 1998; Garbarino et al., 2000; Rajaratnam and Jones, 2004; Folkard and Lombardi, 2004). Moreover it was believed that shift workers feel sleepy at work and are more prone to accidents (Ohayaon et al., 2002).

1.16. Use of Sedative Drugs

The most unfortunate part of shift work is that the shift workers gradually develops increase in their coffee, alcohol, and drug consumption, most probably to facilitate staying awake through out night (Pati, 2001). Consistent with this notion, Waterhouse et al. (2003), reported night workers have an altered food intake during the working hours as compared to their days off and take more snacks than day workers. The study of Assis (1999) investigated the dietary habits of garbage collectors as a function of shift (morning, evening, and night) and documented that during the night and in the early morning hours, night workers frequently had meals and snacks with a higher caloric content (fat and carbohydrate) than day workers.
Thus it can be concluded that gastric problems in shift and night workers occurred due to changes in dietary habits, consumption of drugs that probably help to remain awake.

1.17. Psychological Problems

It is well known that mood of an individual could be influenced by various psychological, physiological, social and situational factors. However, in constant conditions when various environmental factors were excluded, mood exhibited circadian rhythmicity. There are numerous studies documenting that psychological variables are influenced by shift work and especially by night shift (Tasto et al., 1978; Wynne et al., 1986; Bohle and Tilley, 1993). Unusual hours of work may therefore affect job satisfaction. According to Reinberg et al. (1984) intolerance to shift work, sleep disturbances and digestive troubles are associated with fatigue and changes in mood. In other studies, it has been shown that shift work produces negative impact on psychological and behavioral parameters (Park et al., 2000; Pati and Chandrawanshi, 2001; Drake et al., 2001; Kiviamki et al., 2001; Shields, 2002; Dongen et al., 2003; Newey and Hood, 2004). Prizmić et al. (1995) observed significant differences in 24-variation in moods between three groups of oil-refinery workers: tolerant shift workers, intolerant shift workers and workers who had never worked in shifts. Ohida et al. (2000) noticed higher level of anxiety among shift workers and it was more prevalent in hypertensive shift workers (Krivoschekov et al., 2004). In addition, frequency of emotional problems is higher among permanent night workers (Carlla et al., 1999). Depression, helplessness and stress are some of the common psychological problems that shift workers often experience (Healy et al., 1993). The combined effect of shift work, physical workload and work stress influences sleep profile and pattern of a worker (Åkerstedt et al., 2002). Fujino et al. (2001) reported that higher workload is associated with psychiatric problems in permanent night shift workers. Further, shift work produces adverse effects on social and family life (Presser, 2000). Shift workers often experience less family and social interaction that eventually leads to job stress and mental health problems (Larocco et al., 1980, Araki et al., 1993). It has been documented that not only shift workers themselves but their spouses and children also suffer from higher level of anxiety as compared with their respective counterparts related to day workers (Pati and Chandrawanshi, 2001).
Taking into consideration the sex differences and adaptation to shift work, few studies have shown that women’s social and family role exerts an impact on the extent of their adjustment. This is for the reason that in many countries women perform household tasks and take care of the children, thus responsible for a double burden job and domestic life (Rotenberg et al., 2001). On the other hand, there is strong evidence of an involvement of shift work problems related during pregnancy. In an assessment of diseases related to shift work, Knutsson (2003) places of interest, that reliable correlation have been found between shift work and low birth weight, preterm birth and miscarriage. The author also give emphasis to that even in the absence of additional studies, pregnant women should keep away from shift work or night work.

### 1.18. Shift Workers Study in India

In general, peer-reviewed studies of sleep behavior on Indian shift workers are very few. Pati et al. were the most active researchers in the area (Pati et al., 2001; Parganiha and Pati, 2005; Soni et al., 2008). The studies mainly describe changes in circadian physiological and behavioral rhythms as a function of the shift change (Gupta and Pati, 1993a, b, c; Gupta and Pati, 1994a, b; Gupta et al., 1997; Chandrawanshi and Pati, 2000; Pati, 2001; Pati et al., 2001; Parganiha and Pati, 2005).

Recently wrist actigraphy is used to study the negative effect of shift work on sleep parameters (Park et al., 2000; Seo et al., 2000, 2005; Pilcher and Coplen, 2000; Moreno et al., 2003). There are few important studies that have documented sleep problems of shift workers, such as train drivers, truck drivers, nurses, flight controllers by using actigraphy technique (Park et al., 2000; Moreno et al., 2003; Lamond et al., 2005; Minors et al., 1996).

Although, sleep profile in shift workers has been adequately studied, but there has been little research in which wrist actigraphy technique has been used to assess sleep and waking behaviour among shift workers. The objective assessment of sleep behavior has not yet been carried out on Indian population of shift workers. Therefore, the proposed study has been designed to investigate sleep profile in shift workers by using wrist actigraphy. This technique would to have an objective
assessment of various sleep parameters, such as sleep efficiency (SE), time in bed (TIB), assumed sleep (AS), actual sleep time (AST), actual wake time (AWT), sleep bouts (SB), wake bouts (WB) and fragmentation index (FI). The sleep behavior and napping behavior would be studied as function of types of shift rotation adopted by different organizations. In addition, several subjective psychosocial behavior parameters, such as morningness-eveningness preference, job satisfaction, social & domestic satisfaction and disruption, circadian type, and somatic and cognitive anxiety of shift workers would be studied.

1.19. Objectives and Hypothesis

Objectives:

The review of relevant literature clearly indicates that numerous studies have been conducted on the physiological, psychological and behavioral problems related to shift worker's individual and social characteristics taking various dimensions into consideration. But very insufficient insignificant and dependable studies have been conducted which includes all these variables i.e. flexibility of sleeping habits, performance, chronotype preference, job satisfaction, anxiety (both cognitive and somatic), social & domestic satisfaction and disruption problem among shift workers in a single setting jointly.

Further, these problems can be generally classified into three main categories: difficulties with sleep (Åkerstedt, 1990; Mahan et al., 1990; Tepas and Mahan, 1989), impairment of physical and psychological health, including neurotism (Bohle and Tilley, 1989; Knutsson, 1989; Rutenfranz et al., 1985) and social and domestic disruption (Colligan and Rosa, 1990; Walker, 1985). Though, these problems are multifaceted in nature, surprisingly very less efforts has been made in this direction in our country.

Further, even though there are several studies on sleep behavior of shift workers, they are mostly based on questionnaires and sleep logs. Subjective assessment of sleep behavior by using questionnaires has also been studied in Indian shift workers (Gupta and Pati, 1993a, b, c; Gupta and Pati, 1994a, b; Gupta et al., 1997; Chandrawanshi and Pati, 2000; Pati, 2001; Pati et al., 2001; Parganiha and Pati, 2005). The objective assessment of sleep behavior has not yet been carried out on
Indian population of shift workers. In addition, several subjective parameters, such as morningness-eveningness preference, job satisfaction, social & domestic satisfaction and disruption, circadian type, and somatic and cognitive anxiety of Indian shift workers were yet to be evaluated properly.

Therefore, the main objectives of the present Ph. D. dissertation are:

1. To study the impact of different types of shift system on morningness evenness preference (MEQ) and flexibility of sleeping habits and languidness in irregular rotational shift workers (IRS), regular rotational (RS) shift workers, permanent night workers (PNS) and dayworkers (GS);
2. To study the impact of different types of shift system on job satisfaction (JS), social & domestic satisfaction (SS), social & domestic disruption (SD) and cognitive anxiety (Cog A) and somatic anxiety (Som A) of irregular rotational shift workers (IRS), regular rotational (RS) shift workers, permanent night workers (PNS) and dayworkers (GS); and
3. To study various sleep and nap parameters, such as sleep efficiency (SE), time in bed (TIB), assumed sleep (AS), actual sleep time (AST), actual wake time (AWT), sleep bouts (SB), wake bouts (WB) fragmentation index (FI), frequency of naps (NF), total time spent napping (TN), average nap length (AN), and the total time spent napping per 1-hour awake (TN/A) of shiftworkers as function of types of shift rotation adopted by different organizations i.e. irregular rotational shiftwork (IRS), regular rotational shiftwork (RS), permanent night work (PNS) and daywork (GS).

Hypothesis:

1. Correlational Hypothesis:
   a. There will be an interrelationship between different types of shift system (PNS, RS, GS and IRS) and various dimensions of behavioral aspects i.e. flexibility of sleeping habits, languidness, morningness evenness preference, job satisfaction, anxiety (both cognitive and somatic), social & domestic satisfaction and disruption of shift workers.
b. There will be an interrelationship between the dependent variable, flexibility of sleeping habits/ languidness/ morningness evenness preference/ job satisfaction/ anxiety (both cognitive and somatic)/ social & domestic satisfaction/ disruption score and number of independent variables, namely age, weight, height, BSA and BMI.

2. Differential Hypothesis:
   a. Shift workers that adopted different type of shift system would differ from each other in flexibility of sleeping habits, languidness and morningness evenness preference, job satisfaction, anxiety (both cognitive and somatic), social & domestic satisfaction and disruption parameters.
   b. Shift workers that adopted different type of shift system would differ from each other in sleep and nap parameters, such as sleep efficiency (SE), time in bed (TIB), assumed sleep (AS), actual sleep time (AST), actual wake time (AWT), fragmentation index (FI), frequency of naps (NF), total time spent napping (TN), average nap length (AN), and the total time spent napping per 1-hour awake (TN/A) parameters.

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