Sub Name: Rehabilitation Engineering **Department: BME**
Sub Code: BM6801 **Year: IV**

UNIT

PART A

1. What is Rehabilitation?

Rehabilitation focuses on the existing capacities of the handicapped person, and brings him to the optimum level of his or her functional ability by the combined and coordinated use of medical, social, educational and vocational measures. It makes life for the handicapped individual more meaningful, more productive and therefore adds **more life to years.**

2. What is the epidemiology of Rehabilitation?

Epidemiology of Rehabilitation

The word *epidemiology* is derived from the Greek word *epidemios;* meaning "among the people" In the early 20th century, *CO Stallybross* defined epidemiology as *"the science which considers infectious disease—their course, propagation and prevention."*

Epidemiology is concerned with the study of the causative factors of disease and the means to prevent or eradicate it. If complete prevention or total eradication is not possible, containment is the second choice.

WH Welch defined epidemiology as "the study of the natural history of disease."

Lillienfeld described it as the study of "the distribution of a disease or condition in a population, and of the factors that influence this distribution."

3. Define Health.

Health

The definition of health put out by the World Health Organization runs as follows:

"A state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity." The fundamental goal of medical science is not to produce an immortal being but to maintain him in optimum health as long as possible, ideally until death.

4. What do you mean by preventive rehabilitation?

Prevention of disability does not start only at birth, at the onset of disease or after a primary disability occurs. Sometimes it may be done *even before the child is born*, by anticipating disability due to genetic defects or blood group incompatibility and can be prevented by means of genetic counseling. For example in Duchennes muscular dystrophy, it is possible to counsel the parents on having another child who might later display the symptoms of the disease.

5. Give Levels of Prevention.

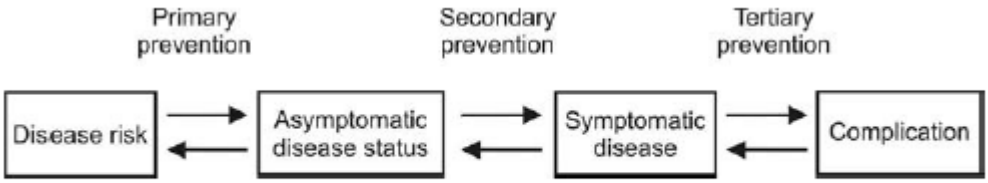


Figure 1.3: Levels of prevention: Primary, secondary and tertiary

6. How disability is diagnosed.

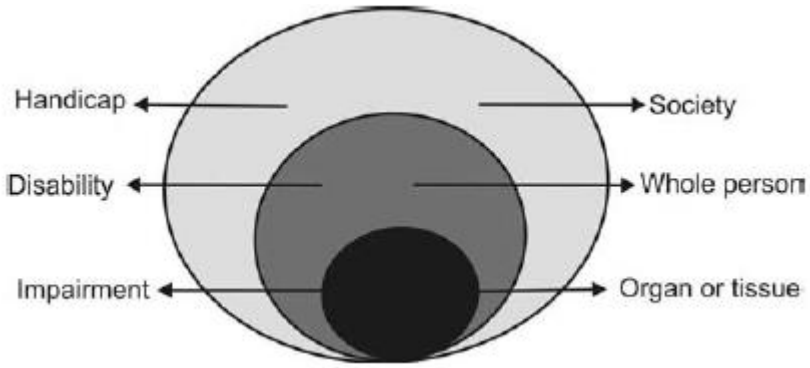
The quantum of disability evaluation varies according to the method used. The most common method of disability evaluation is given as a figure in either percentage or digits based on a specific scale. A Disability Rating rates the patient's inability to do any substantial gainful activity compared to what he was able to do before the onset of the problem. It is calculated by performing general physical, orthopedic, physiatric and neurological examinations of the patient in the rehabilitation center. It helps in identifying the extent of handicap in a person in order to make him or her eligible for certain concessions offered by the Government from time to time.

7. What is Functional Diagnosis?

The diagnosis of the condition of the patient when he comes in to rehabilitation is usually known, but the amount of remaining function is not. Rehabilitation professionals are trained to arrive at a functional diagnosis to evaluate the residual capabilities of the individual and strengthen them. The functional diagnosis should be:

- Objective, using measurable factors so that the results are statistically more reliable.
- Descriptive so that the actual situation is accurately reflected.
- Simple enough so that rapid evaluation is possible.
- Reproduced, so that constancy may be maintained.
- Comprehensive, so that the diagnosis is complete and specifically utilized in the direct care of the patients and is relevant for epidemiological investigation.

8. Give a relationship between impairment, disability and handicap.



9. Differentiate disorder, disease and disability.

Disorder

Disorder can be characterized as a blip in the typical functioning of a man. Basically, disorder is any disease that aggravates the health of a man. Disorders prevent a man's execution and decrease his/her proficiency. Disorders seem paltry at the onset, however they regularly become guilefully in a man. Commonly a disorder can't be identified in time, as an aftereffect of which, a basic issue transforms into disability. With regards to disorders, the most prevalent and usually related term is mind disorder. This is on account of mind disorder are extremely intricate in nature, and very fascinating to the workforce of mental studies, since they regularly request a cure that is a takeoff from typical ways or systems.

Disability

Disability is the outcome of a weakness brought on to a man. It is basically a restorative condition, which doesn't permit a man to work in a normal way. Disability can be available in a man since conception, or can occur amid his/her lifetime. Disabilities can be described into different structures, for example, physical disability, sensory disability, mental disability, olfactory disability, and so forth. It is seen that individuals experiencing disability can't retreat to being as they were some time recently, which is the reason disabled individuals in different nations are qualified to get uncommon concedes and benefits. They're qualified for get a waiver in medications, programmed reservation, committed compartments/seats out in the open transport vehicles, extraordinary gifts concerning instruction and livelihood, and so forth.

10. Why do you need a team during rehabilitation?

In the realm of persons with disability it is not possible for a single person to guide the whole course of rehabilitation. Due to the diverse symptomatology and the spectrum of diseases which lead to disability, optimum results can only be obtained when a group of qualified professionals (where available) get together and chart out a comprehensive program for the relevant disability. Each member contributes in his own area of specialization, and functions with empathy, not sympathy.

11. Give Importance of Psychiatry in functional diagnosis.

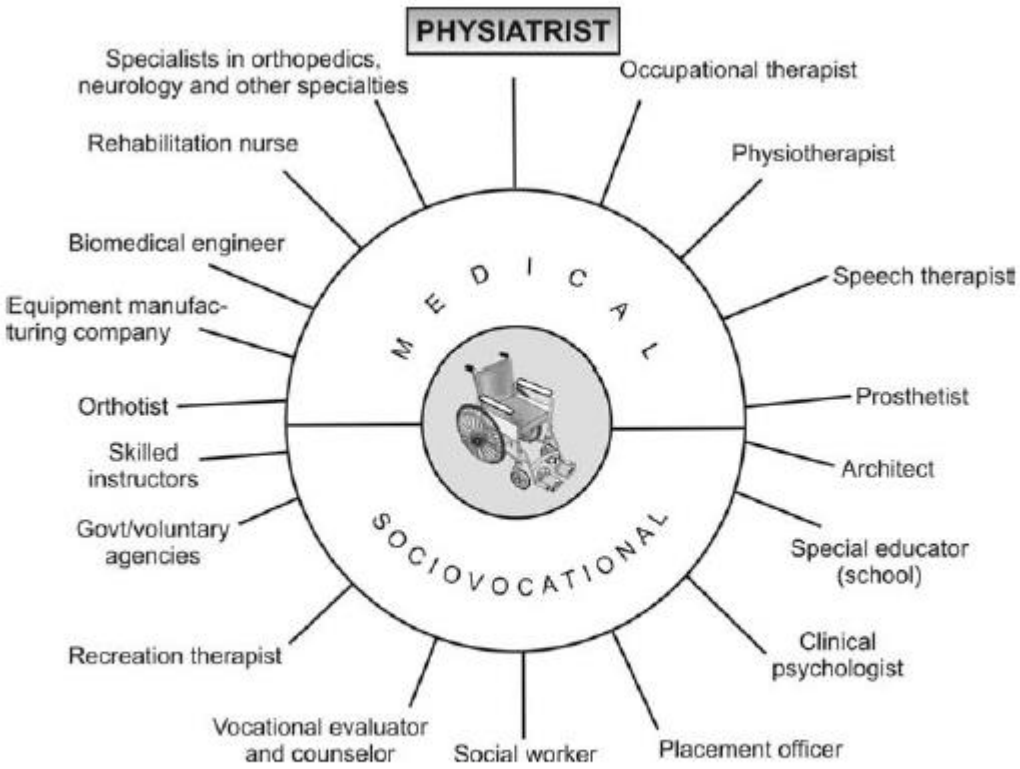


Figure 2.1: The rehabilitation team comprising of the medical team and sociovocational team

12.Give Members of rehabilitation team

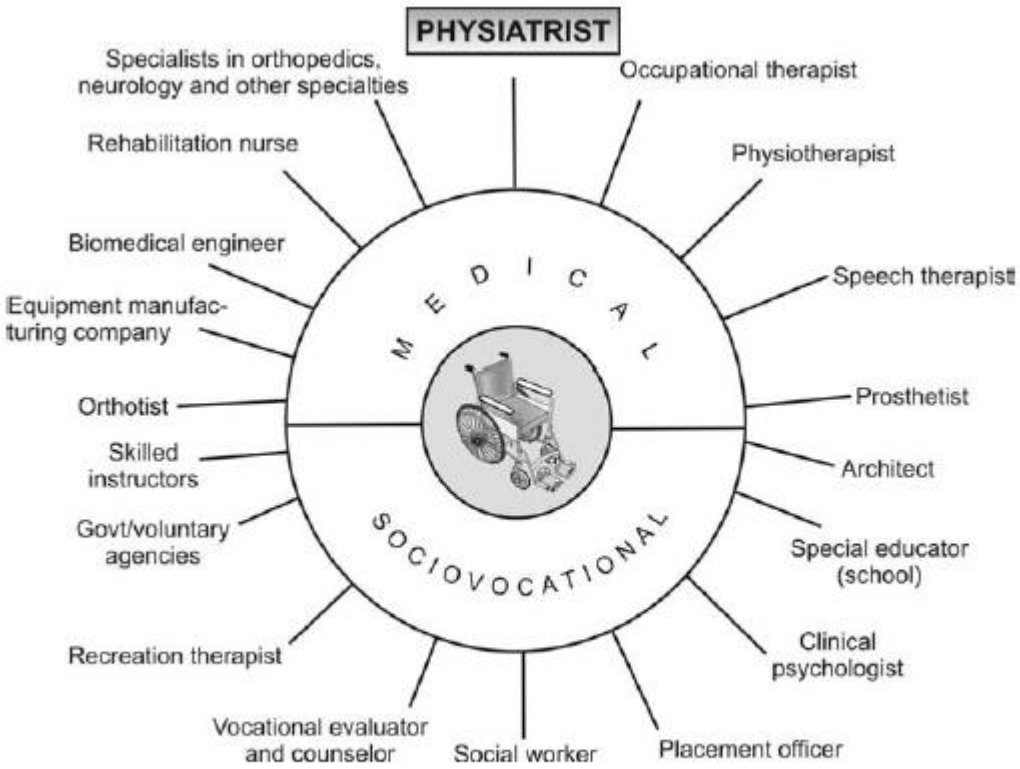


Figure 2.1: The rehabilitation team comprising of the medical team and sociovocational team

13. What is the purpose of orthotist in a rehabilitation team?

Prosthetist-orthotist

The prosthetist-orthotist is responsible for the design, fabrication, and fitting of the orthosis or brace (Ref Chap 7) and prosthesis (artificial limbs *Ref Chap 8*). He makes certain that the device functions and fits properly and that the patient adjusts well to it. The patient and his family are instructed in the maintenance of the prosthesis.

He coordinates with the physiatrist, physiotherapist, occupational therapist and biomedical engineer, to decide the best appliance to be given. Before giving the appliance he would take measurements, fabricate them, making modifications and changes in design where required.

Once ready he fits it to the patient in static and dynamic alignment, repairs it when needed. He often needs to work with the biomedical engineer in the research and development of new material and design.

14. Mention about Music therapist and dance therapist's role in rehabilitation therapy.

Music Therapist

Who does not love music? Music is one of the finest of the fine arts. It can transport one to the highest plane of ecstasy.

The intervention of the music therapist may involve instrumental or vocal performance by the person with disability or helping him appreciate music or attend musical events. This goes a long way in helping children or adults with cerebral palsy or other paralytic conditions. Playing an instrument like the keyboard or the violin improves fine motor skills while dancing or exercising to music (creative movement therapy) is a novel way to improve gross motor milestones. Some children with Down syndrome respond naturally to music. Music helps in relaxation, sedation, or control of pain or anxiety, for those who sing, it improves speech through articulation training or melodic intonation

In those who are immensely talented and in those whose disability enhances musical aptitude, like the visually impaired, music therapy prepares selected patients for music related careers. It improves socialization skills, self-confidence, and esteem through group music activities. For patients in palliative care, it provides the much needed respite.

15. What are the dos and don'ts of a rehabilitation nurse?

- Transfers to and from the bed, wheelchair, chair, and couch
- Environmental factors such as sanitation, heat and noise, control of personal property, hygiene and safety
- The use and maintenance of adaptive equipment needed by patients to communicate, eat, move, defecate, dress, and ambulate (*Ref Chap 11*)
- Specific preventive measures to minimize the effects of inactivity and promote independence
- Integrating various therapies into his daily activities
- Medication and follow-up.

16. Write about role of psychiatrist in rehabilitation therapy.

- *Evaluates the psychological status of the patients*
- *Tests intelligence, memory and perceptual functioning*
- *Incorporates the test results into the care plan*
- *Educates family and patient*
- *Counseling of the family*

17. Write about role of speech pathologist in rehabilitation therapy.

- *Evaluates patients with aphasia, dysarthria, apraxia*
- *Speech, comprehension, reading and writing*

- *Swallowing, feeding*
- *Other communicative problems and proper therapies*
- *High technologies*
- *Family and patient education and counseling*

18. Write about role of biomedical engineer in rehabilitation therapy.

Biomedical Engineer

The field of rehabilitation is an interface between the medical and engineering profession. With the advance of technology, we have newer user friendly environment control units, communication aids, orthoses and limbs. All these have to be designed by electronic and mechanical engineering professionals. The role of the biomedical engineer is to interact with the physiatrist orthotist or speech pathologist to design a piece of equipment, which will be of use to the persons with disability. In many cases the design will have to be unique or customized. Examples of technology used for the handicapped include environment control systems, voice activated wheelchairs and carbon fiber prostheses.

19. What is impairment?

According to the PWD Act 1995, *hearing impairment means loss of 60 decibels or more in the better ear in the conversational frequencies*. Peripheral hearing impairments can be usefully divided into three categories for rehabilitation purposes, based on the side of the lesion responsible for the hearing impairments.

- Conductive impairments prevent transmission of sound to the cochlea. Such lesions occur in the outer or middle ear.
- Sensorineural impairments prevent reception and transmission of sound stimuli to the brain. Such lesion occurs in the cochlea or auditory nerve.
- Mixed or combined impairments - both conductive and sensorineural impairments are present.

Causes for Conductive Impairment

- Congenital atresia of external auditory meatus
- Foreign bodies, e.g. tumor, cartilage or bone in external auditory meatus
- Collapsed ear canal
- Otosclerosis
- Otitis media
- External otitis

Causes of Sensorineural Impairment

- Noise induced hearing loss
- Viral and bacterial disease of inner ear
- Meniere's disease
- Consumption of ototoxic drugs, e.g. aspirin, quinine, neomycin
- Tumors involving cerebellopontine angle.

20. What is primary and secondary disability?

Primary and Secondary Disabilities

Disabilities that are direct consequences of a disease or condition are called *primary disabilities*. Paraplegia following spinal cord injury or inability to walk following hip fracture are examples of primary disability.

On the other hand, disabilities that did not exist at the onset of the primary disability but develop subsequently are called *secondary disabilities*. Secondary disability is indirectly related to the disease or condition that is responsible for the primary disability. Examples are joint contracture in poliomyelitis, subluxation of shoulder joint in hemiplegia, tendo-Achilles contracture in cerebral palsy and pressure sores in paraplegia. Elderly people and those who have had a primary disability for an extended period are more susceptible to a secondary disability. Further, when pain or spasticity accompanies the disease or condition causing the primary disability, the prevalence of secondary disability increases. Negligence or ignorance on the part of paramedical personnel or family members results in placing the person with disability in positions that promote secondary disability.

PART B

1. What is Rehabilitation team? Explain the role of members in detail.
2. Explain the levels of Prevention in detail.
3. What is Rehabilitation engineering and write about its epidemiology.
4. Explain the functional diagnosis and its importance.
5. Explain the role and need of
    i) Speech pathologist
    ii) Rehabilitation nurse
6. Explain about preventive rehabilitation and the importance of psychiatry in functional diagnosis.
7. Write a detailed note on impairment, disability and handicap.
8. Explain the role of
    i) Social worker
    ii) Biomedical Engineer

UNIT 2

PART A

1. Write a short note on Human Component.
   - To knowledgeably apply engineering principles and fabricate devices that will help persons with disabling conditions, it is necessary to have a perspective on the human component and the consequence of various impairments.
   - One way to view a human being is as a receptor, processor, and responder of information.
2. What are the Principles of Assistive Technology Assessment?
   - Rehabilitation engineers not only need to know the physical principles that govern their designs, but they also must adhere to some
   - To be successful, the needs,preferences, abilities, limitations, and even environment of the individual seeking the assistive technology must be carefully considered.
   - Key principles that govern the applications of technology for people with disabilities.
3. What are the Principles of Rehabilitation Engineering?
   - Knowledge and techniques from different disciplines must be utilized to design technological solutions that can alleviate problems caused by various disabling conditions.
   - Since rehabilitation engineering is intrinsically multidisciplinary, identifying universally applicable principles for this emerging field is difficult.
   - Often the most relevant principles depend on the particular problem being examined. For example, principles from the fields of electronic and communication engineering are paramount when designing

an environmental control system that is to be integrated with the user's battery-powered wheelchair.

4. Give Key Engineering Principles.
    - Each discipline and sub discipline that contributes to rehabilitation engineering has its own set of key principles that should be considered when a design project is begun.
    - For example, a logic family must be selected and a decision whether to use synchronous or asynchronous sequential circuits must be made at the outset in digital design.
    - A few general hardware issues are applicable to a wide variety of design tasks, including worst-case design, computer simulation, temperature effects, reliability, and product safety.
5. Give Key Ergonomic Principles.
    - Ergonomics or human factors is another indispensable part of rehabilitation engineering and assistive technology design.

- Principle of Proper Positioning
- Principle of the Anatomical Control Site
- Principle of Simplicity and Intuitive Operation
- Principle of Display Suitability
- Principle of Allowance for Recovery from Errors
- Principle of Adaptability and Flexibility
- Principle of Mental and Chronological Age Appropriateness

6. How Rehabilitation and Assistive Technology are practiced.

For example, Medi-Cal, the California version of the federally funded medical assistance program, now funds the purchase and customization of augmentative communication devices. Many states routinely fund technology devices that enable people with impairments to function more independently or to achieve gainful employment.

7. What is analysis?

Analysis

Inexperienced but enthusiastic rehabilitation engineering students often respond to a plea for help from someone with a disability by immediately thinking about possible solutions. They overlook the important first step of doing a careful analysis of the problem or need. What they discover after much ineffectual effort is that a thorough investigation of the problem is necessary before any meaningful solution can be found. Rehabilitation engineers first must ascertain where, when, and how often the problem arises. What is the environment or the task situation? How have others performed the task? What are the environmental constraints (size, speed, weight, location, physical interface, etc.)? What are the psychosocial constraints (user preferences, support of others, gadget tolerance, cognitive abilities, and limitations)? What are the financial considerations (purchase price, rental fees, trial periods, maintenance and repair arrangements)? Answers to these questions will require diligent investigation and quantitative data such as the weight and size to be lifted, the shape and texture of the object to be manipulated, and the operational features of the desired device. An excellent endpoint of problem analysis would be a list of operational features or performance specifications that the "ideal" solution should possess.

8. What is synthesis?

Synthesis

A rehabilitation engineer who is able to describe in writing the nature of the problem is likely to have some ideas for solving the problem. Although not strictly sequential, the synthesis of possible solutions usually follows the analysis of the problem. The synthesis of possible solutions is a creative activity that is guided by previously learned engineering principles and supported by handbooks, design magazines, product catalogs, and consultation with other professionals. While making and evaluating the list of possible solutions, a deeper understanding of the problem usually is reached and other, previously not apparent, solutions arise. A recommended endpoint for the synthesis phase of the design process includes sketches and technical descriptions of each trial solution.

9. What is evaluation?

Evaluation

Depending on the complexity of the problem and other constraints such as time and money, the two or three most promising solutions should undergo further evaluation, possibly via field trials with mockups, computer simulations, and/or detailed mechanical drawings. Throughout the evaluation process, the end user and other stakeholders in the problem and solution should be consulted. Experimental results from field trials should be carefully recorded, possibly on videotape, for later review. One useful method for evaluating promising solutions is to use a quantitative comparison chart to rate how well each solution meets or exceeds the performance specifications and operational characteristics based on the analysis of the problem.

10. What is decision?

Decision

The choice of the final solution is often made easier when it is understood that the final solution usually involves a compromise. After comparing the various promising solutions, more than one may appear equally satisfactory. At this point, the final decision may be made based on the preference of the user or some other intangible factor that is difficult to anticipate. Sometimes choosing the final solution may involve consulting with someone else who may have encountered a similar problem. What is most important, however, is careful consideration of the user's preference (principle 5 of assistive technology).

11. What is implementation?

Implementation

To fabricate, fit, and install the final (or best) solution requires additional project planning that, depending on the size of the project, may range from a simple list of tasks to a complex set of scheduled activities involving many people with different skills.

12. What is Principle of Mental and Chronological Age Appropriateness

Principle of Mental and Chronological Age Appropriateness

When working with someone who has had lifelong and significant disabilities, the rehabilitation engineer cannot presume that the mental and behavioral age of the individual with disabilities will correspond closely with that person's chronological age. In general, people with congenital disabilities tend to have more limited variety, diversity, and quantity of life experiences. Consequently, their reactions and behavioral tendencies often mimic those of someone much younger. Thus, during assessment and problem definition, the rehabilitation engineer should ascertain the functional age of the individual to be helped. Behavioral and biographical information can be gathered by direct observation and by interviewing family members, teachers, and social workers.

13. What is Principle of Display Suitability

Principle of Display Suitability

In selecting or designing displays for transmission of information, the selection of the sensory modality is sometimes a foregone conclusion, such as when designing a warning signal for a visually impaired person. When there is an option, however, the rehabilitation engineer must take advantage of the intrinsic advantages of one sensory modality over another for the type of message or information to be conveyed. For example, audition tends to have an advantage over vision in vigilance types of warnings because of its attention-getting qualities. A more extensive comparison of auditory and visual forms of message presentation is presented in Table 5.7.

14.What is Principle of Simplicity and Intuitive Operation

Principle of Simplicity and Intuitive Operation

The universal goal of equipment design is to achieve intuitively simple operation, and this is especially true for electronic and computer-based assistive devices. The key to intuitively simple operation lies in the proper choice of compatible and optimal controls and displays. *Compatibility* refers to the degree to which relationships between the control actions and indicator movements are consistent, respectively, with expectations of the equipment's response and behavior. When compatibility relationships are incorporated into an assistive device, learning is faster, reaction time is shorter, fewer errors occur, and the user's satisfaction is higher. Although people can and do learn to use adaptations that do not conform to their expectations, they do so at a price (producing more errors, working more slowly, and/or requiring more attention). Hence, the rehabilitation engineer needs to be aware of and follow some common compatibility relationships and basic ergonomic guidelines, such as:

- The display and corresponding control should bear a physical resemblance to each other.
- The display and corresponding control should have similar physical arrangements and/or be aided by guides or markers.
- The display and corresponding control should move in the same direction and within the same spatial plane (e.g., rotary dials matched with rotary displays, linear vertical sliders matched with vertical displays).
- The relative movement between a switch or dial should be mindful of population stereotypic expectations (e.g., an upward activation to turn something on, a clockwise rotation to increase something, and scale numbers that increase from left to right).

Additional guidelines for choosing among various types of visual displays are given in Table 5.6.

15.What is Principle of the Anatomical Control Site

Principle of the Anatomical Control Site

Since assistive devices receive command signals from the users, users must be able to reliably indicate their intent by using overt, volitional actions. Given the variety of switches and sensors that are available, any part of the body over which the user has reliable control in terms of speed and dependability can serve as the anatomical control site. Once the best site has been chosen, an appropriate interface for that

site can be designed by using various transducers, switches, joysticks, and keyboards. In addition to the obvious control sites such as the finger, elbow, shoulder, and knee, subtle movements such as raising an eyebrow or tensing a particular muscle can also be employed as the control signal for an assistive device. Often, the potential control sites can and should be analyzed and quantitatively compared for their relative speed, reliability, distinctiveness, and repeatability of control actions. Field trials using mock-ups, stopwatches, measuring tapes, and a video camera can be very helpful for collecting such performance data.

When an individual's physical abilities do not permit direct selection from among a set of possible choices, single switch activation by the anatomical control site in combination with automated row-column scanning of a matrix is often used. In row-column scanning, each row of a matrix lights up sequentially from the top to the bottom. When the row containing the desired item is highlighted, the user selects it using a switch. Then each item in that row is scanned (from left to right) until the desired item is chosen by a second switch activation. The speed with which a two-dimensional array can be used to compose messages depends on the placement of the letters in that array. Two popular arrangements of alphanumeric symbols—the alphabetic arrangement and the frequency of occurrence arrangement of the alphabet—are shown in Example Problem 5.5.

16. What is Principle of Proper Positioning

Principle of Proper Positioning

Without proper positioning or support, an individual who has lost the ability to maintain a stable posture against gravity may appear to have greater deformities and functional limitations than truly exist. For example, the lack of proper arm support may make the operation of even an enlarged keyboard unnecessarily slow or mistake prone. Also, the lack of proper upper trunk stability may unduly limit the use of an individual's arms because the person is relying on them for support.

During all phases of the design process, the rehabilitation engineer must ensure that whatever adaptation or assistive technology is being planned, the person's trunk, lower back, legs, and arms will have the necessary stability and support at all times (Fig. 5.9). Consultation with a physical therapist or occupational therapist familiar with the focus individual during the initial design phases should be considered if postural support appears to be a concern. Common conditions that require considerations of seating and positioning are listed in Table 5.5.

17. What is Principle of Allowance for Recovery from Errors

Both rehabilitation engineering and human factors or ergonomics seek to design assistive technology that will expand an individual's capabilities while minimizing errors. However, human error is unavoidable no matter how well something is designed. Hence, the assistive device must provide some sort of allowance for errors without seriously compromising system performance or safety. Errors can be classified as errors of omission, errors of commission, sequencing errors, and timing errors.

18. What is Principle of Adaptability and Flexibility

One fundamental assumption in ergonomics is that devices should be designed to accommodate the user and not vice versa. As circumstances change and/or as the user gains greater skill and facility in the operation of an assistive device, its operational characteristics must adapt accordingly. In the case of an augmentative electronic communication device, its vocabulary set should be changed easily as the user's needs, skills, or communication environment change. The method of selection and feedback also should be flexible, perhaps offering direct selection of the vocabulary choices in one situation while reverting to a simpler row-column scanning in another setting. The user should also be given the choice of having auditory, visual, or a combination of both as feedback indicators.

19. What is Principle of Mental and Chronological Age Appropriateness

When working with someone who has had lifelong and significant disabilities, the rehabilitation engineer cannot presume that the mental and behavioral age of the individual with disabilities will correspond closely with that person's chronological age. In general, people with congenital disabilities tend to have more limited variety, diversity, and quantity of life experiences. Consequently, their reactions and behavioral tendencies often mimic those of someone much younger. Thus, during assessment and problem definition, the rehabilitation engineer should ascertain the functional age of the individual to be helped. Behavioral and biographical information can be gathered by direct observation and by interviewing family members, teachers, and social workers.

20. What is role of Medicare in assistive technology?

A. Medical Assistance (Medicaid)

Medical Assistance is publicly-funded health insurance for eligible children and adults, including many persons with disabilities. Medical Assistance is provided by managed care health plans or is fee for service (ACCESS or ACCESS Plus). You can apply for Medical Assistance through your local County Assistance Office.

PART B

1) Explain Principles of Assistive Technology Assessment
2) Explain the Principles of Rehabilitation Engineering in detail
3) Briefly write a note on Key Engineering Principles.
4) Briefly write a note on Key Ergonomic Principles.
5) How Rehabilitation and Assistive Technology are practiced

6) Explain about the performance implementation and specifications for an electro mechanicaldevice to raise and lower the lower leg of a wheel chair user (to prevent edema)

PART -C

17. Under static or constant velocity conditions, the wheelchair will tip backwards if the vertical projection of the combined center of gravity (*CG*) of the wheelchair and occupant falls behind the point of contact between the rear wheels and the ramp surfaces. As shown in Figure 5.12, the rearward tipover angle (θ_r) is determined by the horizontal distance (d_1) and the vertical distance (d_2) between *CG* and the wheelchair's rear axles.

a) Using static analysis, derive the equation relating θ_r, d_1, and d_2.

b) Using the platform approach depicted in Figure 5.7, suggest a method for determining d_1.

c) Assuming that d_1 and d_2 averaged 13 cm and 24 cm, respectively, for able-bodied individuals, what would θ_r be?

d) How would d_1 and d_2 change if the wheelchair occupant leaned forward instead of sitting back against the chair? How would θ_r be affected by this postural shift?