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# UNIVERSITY OF MYSORE

Established: 1916

Vishwavidyanilaya Karyasoudha
Crawford Hall, Mysore-570 005

No.AC.2(S)/151/2021-22

Dated: 18.08.2021

## NOTIFICATION

**Sub:** Correction of typographical error in regulations of M.Sc (Audiology).

**Ref:** 1. Decision of Board of Studies in Audiology (PG) meeting held on 08.12.2020.
2. Decision of the Faculty of Science & Technology Meeting held on 08.02.2021.
3. Decision of the Academic Council meeting held on 07.04.2021.

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The Board of Studies in Audiology (PG) which met on 08.12.2020 has made Correction a typographical error in the credits for dissertation in the regulations of M.Sc (Audiology). The credits for dissertation in IV Semester is typed as 5 instead of 4, the same may be modified to 4 credits.

The Faculty of Science and Technology and Academic Council meeting held on 08.02.2021 and 07.04.2021. respectively have approved the above said proposal and the same is hereby notified.

The detailes of this course is annexed. The contents may be downloaded **from the University Website i.e., www.uni-mysore.ac.in**.

**DRAFT APPROVED BY THE REGISTRAR**

18/8

**DEPUTY REGISTRAR (ACADEMIC)**

Deputy Registrar (Academic)
University of Mysore
Mysore-570 005

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DoS in Psychology, MGM.
3. The Director, All India Institute of Speech and Hearing, Manasagangotri, Mysore.
4. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
5. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
6. Office file.

## SEMESTER I

## Paper Code: AUD 1.1 - HC: Research Methods and Statistics in Speech – Language and Hearing

### Objectives

**After successful completion of this course the students should be able to:**

1. Understand and deduce the use of research methods.
2. Choose appropriate research designs to carry out research in the field.
3. Apply statistics in the field of Speech-Language Pathology and Audiology.
4. Critically evaluate the research designs and statistics in research publications.

### Unit 1: Research strategies and their statistical counterpart 18 Hrs

1.1 Overview of variables
- Dependent
- Independent
  - Active and attribute
  - Continuous and categorical variables
- Extraneous and control variables

1.2 Quantitative Research
- Experimental research
  - Bivalent
  - Multivalent
  - Parametric
- Descriptive research
  - Comparative research
  - Developmental research
  - Correlational research
  - Survey research
  - Retrospective research
- Combined experimental and descriptive research

1.3. Qualitative research
- Observational research
- Interview research
- Narrative research
- Case study research

1.4. Documentation
- Organization
- Formatting

1.5 Writing style: Theses and journal articles

**Unit 2 : Research designs 18 Hrs**

2.1 Group designs
- Within group
- Between group
- Mixed designs

2.2 Single subject designs
- Withdrawal and reversal design
- Multiple base line
- Changing criterion design

2.3 Treatment Designs
- Pre-experimental
- Quasi experimental
- True experimental

2.4 Evidence based practice
- Generalization of research findings
- Levels of evidence
- Barriers to evidence-based practice

2.5 Validity of research designs
- Internal validity
- External validity

**Unit 3: Parametric tests and its application 18 Hrs**

3.1 Overview of basic statistics
- Measures of central tendency
- Measures of dispersion
- General properties of normal distribution
- Variants from normal distribution
- Methods of correlation

3.2 Simple and multiple linear regression (with numerical examples)

3.3 Hypotheses and testing of hypotheses

3.3 Testing the significance between two means (with numerical examples)
- Independent samples t-test
- Paired sample t-test

3.4 Analysis of variance (ANOVA)
- Types of ANOVA
- Basic model
- Assumptions underlying ANOVA
- One-way and two-way ANOVA (with numerical examples)
- Need for Post-hoc tests
- Concept of repeated measures ANOVA and ANCOVA

3.5 Multivariate data analysis (concept only)

- Need for multivariate data analysis
- Introduction to various methods
  - Principal component analysis
  - Cluster analysis
  - Discriminant analysis
  - MANOVA

**Unit 4: Non-parametric tests, qualitative data analyses and their application 18 Hrs**

4.1 Consequences of failure of assumptions underlying parametric tests

4.2 Need for transformations and non-parametric tests

4.3 Non-parametric tests for independent samples (with numerical examples)

- Median test
- Mann-Whitney U test
- Kruskal-Wallis test

4.4 Non-parametric tests for related samples (with numerical examples)

- Sign test
- Wilcoxon's signed-rank test
- Friedman's test

4.5 Analysis of qualitative data (with numerical examples)

- Contingency tables
- Chi-square test for independence of attributes
- Measures of Association- contingency coefficient and Cramer's
- Measures of agreement - Kappa coefficient

**Practicum:**

1. Review research methods and statistics used in publications in the field of communication disorders in blocks of 5 years from 1970.
2. Two journal articles should be reviewed by each student for variables, research methods and appropriateness of statistics.

**Reference:**

**Unit 1:**

1. Grosof. M.S., Sardy. H. (1985). A research primer for the social & behavioral sciences. New York. Academic press.
2. Hegde, M.N. (1987). Clinical Research in Communicative Disorders. Principles and Strategies, Boston,. College-Hill Press.
3. Hegde, M.N. (1994). Clinical Research in Communicative Disorders. Principles and Strategies, Austin, ProEd.

4. Lindlof (1995). Qualitative communication research methods, California, Sage publications.
5. Maxwellsatake (1997). Research and statistical methods in communication disorders, Baltimore, Williams & Wilkins.
6. Pannbaker M.H. (1994). Introduction to clinical research in communication disorders, Sandiego, Singular publishing group.
7. Schiavetti Metz (1997). Evaluating research in communication disorders, Boston, Allyn & Bacon.
8. Orlikoff, R. F., Schiavetti, N., & Metz, D. E. (2015). Evaluating Research in Communication Disorders. New York: Pearon.
9. Tucker (1981). Research in speech communication, Prentice Hall. Inglewood cliffs.
10. Ventry. I. M.& Schiavetti N. (1980). Evaluating research in speech pathology and Audiology, London. Addison Wesley.

**Unit 2:**

1. Broota (1989). Experimental design in behavioral research. Eastern New Delhi, Wiley. Doehring (1988). Research strategies in human communication disorders, Austin, Proed.
2. Frey (1991). Investigating communication. An introduction to research methods. Inglewood cliffs, Prentice Hall.
3. Silverman F.H. (1985). Research design and evaluation in speech language pathology, Audio logy. Asking questions & answering, Newjersy, Prentice Hall.
4. Silverman, F.N. (1988) Research designs in speech pathology and audiology. Boston. Allyn & Bacon.
5. Haynes, W. O., & Johnson, C. (2009). Understanding Research and Evidence based practice in communication disorders. Boston: Pearson.

**Unit 3**

1. Argyrous, G. (2014). Statistics for Research. 2nd Ed. New Delhi: SAGE Publications (SA).
2. Cox, T.F. (2014). An Introduction to Multivariate Data Analysis. New Delhi: Wiley India (P) Ltd.
3. Gupta, K.R. (2014). Statistics. Vol. 1. New Delhi: Atlantic Publishers & Distributors (P) Ltd.
4. Gupta, K.R. (2014). Statistics. Vol. 2. New Delhi: Atlantic Publishers & Distributors (P) Ltd.
5. Field, A. (2013). Discovering Statistics using IBM SPSS Statistics. 4th Ed. New Delhi: SAGE Publications.
6. Martin, W.E., & Bridgmon, K.D. (2012). Quantitative and Statistical Research Methods – From Hypothesis to Results. San Francisco: Jossey – Bass.

7. Kapur, S.K. (2008). Elements of Practical Statistics. 3rd Ed. New Delhi: Oxford & IBH Publishing Co.
8. Maxwell, D.L., & Satake, E. (2006). Research and Statistical Methods in Communication Sciences and Disorders. Canada: Thomson Publications.
9. Salkind, N.J. (2000). Statistics for people who (think they) hate statistics. California: SAGE Publications.
10. Michael, S.L. (Editor) (1993). Regression analysis – International handbooks of quantitative applications in the social sciences. Vol. 2. London: Sage Publications.
11. Johnsonwichern (1992). Applied multivariate statistical analysis. New Jersey: Prentice Hall.
12. Garrett, H.E., & Woodworth, R.S. (1979). Statistics in Psychology and Education. 9th Ed. Bombay: Feffer & Simons.
13. Gupta, S.P. (1977). Practical Statistics. 3rd Ed. New Delhi: S. Chand & Company Ltd.

**Unit 4**

1. Argyrous, G. (2014). Statistics for Research. 2nd Ed. New Delhi: SAGE Publications.
2. Gupta, K.R. (2014). Statistics – Vol. 2. New Delhi: Atlantic Publishers & Distributors (P) Ltd.
3. Field, A. (2013). Discovering Statistics using IBM SPSS Statistics. 4th Ed. New Delhi: SAGE Publications
4. Martin, W.E., & Bridgmon, K.D. (2012). Quantitative and Statistical Research Methods – From Hypothesis to Results. San Francisco: Jossey – Bass.
5. Kapur, S.K. (2008). Elements of Practical Statistics. 3rd Ed. New Delhi: Oxford & IBH Publishing Co.
6. Gibbons, J.D. (1993). Non-parametric Statistics: An Introduction. California: Sage Publications
7. Leach, C. (1979). Introduction to Statistics – A Non-parametric approach for the social sciences. New York : John Wiley & Sons
8. Gupta, S.P. (1977). Practical Statistics. 3rd Ed. New Delhi: S.Chand & Company Ltd.
9. Ferguson, G.A. (1976). Statistical Analysis in Psychology and Education. Tokyo: McGraw-Hill Kogakusha, Ltd.
10. Seigal, S. (1956). Non-parametric Statistics for the Behavioral Sciences. Tokyo: McGraw Hill.

## Paper Code: AUD 1.2 - HC: Auditory Perception

**Objectives**

**After studying this course student will be familiarized:**

1. With various psycho-acoustical procedures used for assessing the functions of auditory system,
2. With the effects of sensori neural hearing loss of varying degrees and configuration on different psycho-acoustic tasks.
3. With outcomes and implications of these psycho-acoustic tasks.
4. With analyses and interpretation of results from psychophysical experiments

**Unit 1:** Introduction **to Psycho-Acoustics 18 Hrs**

1.1 Physical description and parameters for generation of sounds
- Sine wave and complex signals
- Analysis of sound: Spectrum and spectrogram, LTASS
- Filters and their properties

**1.2** Theory of signal detection
- Basic concepts
- Applications

**1.3** Psychophysical methods
- Classical methods
- Adaptive methods

Unit 2: Absolute and Relative Thresholds 18 Hrs

2.1 Overview of absolute and relative measures
- Methods of measuring absolute and relative threshold (Difference limen for physical parameters of sound)
- Thresholds of audibility (MAP & MAF)

2.2 Loudness perception in individuals with normal hearing and in individuals with hearing impairment (different degrees, configuration and types)
- Dynamic range of hearing, equal loudness contours and loudness scaling.
- Models of loudness.
- Factors affecting loudness: Bandwidth, duration, adaptation and masking.
- DLI
- Recruitment and softness imperception
- Consequences of altered loudness perception

**2.3** Pitch perception in individuals with normal hearing and in individuals with hearing impairment (different degrees, configuration and types)
- Theories of pitch perception
- Pitch Scales
- Perception of pure-tones
  - Frequency discrimination
  - Pitch perception of pure-tones

- Effect of intensity on pitch
- Perception of complex signals
  - Theories of pitch perception for complex signals
  - Missing fundamental
  - Discrimination of complex tones
  - Consequences of altered pitch perception

Unit 3: Frequency selectivity in individuals with normal hearing and in individuals with hearing impairment (different degrees, configuration and types) 18 Hrs

3.1 Measurement of frequency sensitivity using masking experiments
- Critical band concept and power spectrum model.
- Estimating the shape of auditory filter
  - Psycho-physical tuning curve
  - Notched noise
  - Non-simultaneous masking
- Masking patterns and excitation patterns.

3.2 Non-peripheral masking phenomena
- Central masking
- Informational masking
- Overshoot phenomena
- Co-modulation masking release
- Consequences of reduced frequency selectivity

**Unit 4: Temporal processing in individuals with normal hearing and in individuals with hearing impairment (different degrees, configuration and types) 18 Hrs**

4.1 Overview of temporal processing
- Temporal resolution
- Temporal integration
- Models of temporal processing

4.2 Detection and discrimination of gaps in
- Broad band noise
- Narrow band noise
- Sinusoids

4.3 Temporal modulation transfer function using
- Broad band noise
- Narrow band noise
- Sinusoids

4.4 Discrimination of modulation frequency

4.5 Consequences of altered temporal processing

**Practicum:**

- Generation of sinusoid and complex signals, LTASS of complex signals.
- Measure loudness curve/growth function (Magnitude scaling), growth of masking on 5 individuals with normal hearing.
- Measure temporal integration on 5 individuals with normal hearing.
- Measure TMTF on 5 individuals with normal hearing.
- Carry out non simultaneous masking on 5 individuals with normal hearing.
- Measure PTC on 2 individuals with normal hearing**.**

**References:**

**Unit 1: Introduction to psycho-acoustics**


1. Gelfand, S, A. (2005). Introduction to psychological and physiological acoustics. New York: Marcel Dekker.
2. Moore, B. C. J. (1995). Hearing. San Diego: Academic Press.
3. Moore, B. C. J. (1997). Introduction to psychology of hearing, San Diego: Academic Press.
4. Pickles. J.O. (2008). Introduction to Physiology of Hearing. San Diego: Academic Press.
5. Warren, R. M. (2008). Auditory Perception: An Analysis and Synthesis. Cambridge: Cambridge University Press.
6. Yost, W. A. (1994). Fundamentals of hearing: An introduction. San Diego: Academic Press.
7. Zwicker, E., & Fastl, H. (1999). Psychoacoustics-Facts and models. Springer Verlag: Berlin Heidelberg.
8. Stuart Rosen & Deter Howell (1991). Signals and systems for speech and hearing. CA: Academic Press Inc. (Chapters 2, 3, 6, 7, 8, 9, 10 and 12).


**Unit 2: Absolute and relative thresholds**


1. Gelfand, S, A. (2005). Introduction to psychological and physiological acoustics. New York: Marcel Dekker.
2. Moore, B. C. J. (1995). Hearing. San Diego: Academic Press.
3. Moore, B. C. J. (1997). Introduction to psychology of hearing, San Diego: Academic Press.
4. Pickles, J.O. (2008). Introduction to Physiology of Hearing. Academic Press.
5. Warren, R. M. (2008). Auditory Perception: An Analysis and Synthesis. Cambridge: Cambridge University Press.
6. Yost, W. A. (1994). Fundamentals of hearing: An introduction. San Diego: Academic Press.
7. Zwicker, E., & Fastl, H. (1999). Psychoacoustics-Facts and models. Springer Verlag: Berlin Heidelberg.
8. **Plack, C.J., Oxenham, A.J., & Fay, R.R. (2005).** Pitch: Neural Coding and Perception. New York: Springer.
9. Brain, C.J. Moore (1998). Cochlear Hearing Loss. (2nd and 3rd Editions). London: Whurr Publishers.
10. Brain C.J., Moore (2007). Cochlear Hearing Loss: Physiological, Psychological and Technical Issues. England: John Wiley and Sons Ltd.

**Unit 3: Frequency selectivity in individuals with normal hearing and in individuals with hearing impairment (different degrees, configuration and types)**


1. Gelfand, S, A. (2005). Introduction to psychological and physiological acoustics. New York: Marcel Dekker.
2. Moore, B. C. J. (1995). Hearing. San Diego: Academic Press.
3. Moore, B. C. J. (1997). Introduction to psychology of hearing. San Diego: Academic Press.
4. Pickles, J.O. (2008). Introduction to Physiology of Hearing. San Diego: Academic Press.
5. Warren, R. M. (2008). Auditory Perception: An Analysis and Synthesis. Cambridge: Cambridge University Press.
6. Yost, W. A. (1994). Fundamentals of hearing: An introduction. San Diego: Academic Press.
7. Zwicker, E., & Fastl, H. (1999). Psychoacoustics-Facts and models. Springer: Verlag Berlin Heidelberg.
8. Brain, C.J. Moore (1986). Frequency selectivity in Hearing. CA: Academic Press Inc.
9. Brain, C.J. Moore (1998). Cochlear Hearing Loss. (2nd and 3rd Editions). London: Whurr Publishers.
10. Brain, C.J. Moore (2007). Cochlear Hearing Loss: Physiological, Psychological and Technical Issues. England: John Wiley and Sons Ltd.
11. Oxenham, A., & Bacon, S. (2003). Cochlear Compression: Perceptual Measures and Implications for Normal and Impaired Hearing. *Ear and Hearing*, 24, 350-366.
12. Stanley, A. Gelfand (1998). Hearing. New York: Marcel Dekker Inc.


**Unit 4: Temporal processing in individuals with normal hearing and in Individuals with hearing impairment (different degrees, configuration and types)**


1. Gelfand, S, A. (2005). Introduction to psychological and physiological acoustics. New York: Marcel Dekker.
2. Moore, B. C. J. (1995). Hearing. San Diego: Academic Press.
3. Moore, B. C. J. (1997). Introduction to psychology of hearing, San Diego: Academic Press.
4. Pickles. J.O. (2008). Introduction to Physiology of Hearing. San Diego: Academic Press.
5. Warren, R. M. (2008). Auditory Perception: An Analysis and Synthesis. Cambridge: Cambridge University Press.
6. Yost, W. A. (1994). Fundamentals of hearing: An introduction. San Diego: Academic Press.
7. Zwicker, E., & Fastl, H. (1999). Psychoacoustics-Facts and models. Springer-Verlag: Berlin Heidelberg.
8. Brain, C.J. Moore (1998). Cochlear Hearing Loss. (2nd and 3rd Editions). London: Whurr Publishers.
9. Brain C.J. Moore (2007). Cochlear Hearing Loss: Physiological, Psychological and Technical Issues. England: John Wiley and Sons Ltd.
10. Oxenham, A., & Bacon, S. (2003). Cochlear Compression: Perceptual Measures and Implications for Normal and Impaired Hearing. *Ear and Hearing*, 24, 350-366.
11. Stanley, A. Gelfand (1998). Hearing. New York: Marcel Dekker Inc.

## Paper Code: AUD 1.3 - HC: Physiological Assessment of the Auditory System

**Objectives**

**After completing this course, the candidate shall be able to**

1. Describe the bases of physiological tests
2. Independently administer different physiological tests, interpret the findings
3. Make need-based modifications in the test protocol
4. Prepare research proposal to conduct research in the domain of physiological tests

### Unit 1: Tympanometry 18 Hrs

1.1 Overview of principles and instrumentation of immittance evaluation
1.2 Overview on Single component tympanometry and its applications
1.3 Multi-frequency and multi-component tympanometry
1.4 Variables affecting multiple component and multi-frequency tympanometry
1.5 Tympanometry in infants
1.6 Implication of tympanometric evaluation in differential diagnosis and management
1.7 Wideband reflectance/absorbance and wideband tympanometry: Bases, instrumentation, test administration, interpretation and clinical applications

### Unit 2 - Reflexometry 18 Hrs

2.1 Overview of Acoustic reflexes: pathway, test protocol, administration and clinical implications
2.2 Reflex patterns in different pathologies
2.3 Overview on special tests of acoustic reflexes and their applications: Reflex adaptation, latency of acoustic reflex, reflex averaging, reflex sensitization, Temporal summation of acoustic reflex, binaural summation of acoustic reflex
2.4 Variables affecting their measurement of acoustic reflexes
2.5 Importance of high frequency reflexometry in paediatric assessment
2.6 Reflectometry
2.7 Non-acoustic reflexes: pathway, test protocol, administration and clinical implications
2.8 Research needs in middle ear muscle reflexes

### Unit 3: Otoacoustic emissions 18 Hrs

3.1 Origin of OAEs
3.2 Classifications of OAEs **with special focus on mechanism based taxonomy**
3.3 Principles and recording techniques of different types of OAEs
3.4 Interpretation of OAEs: amplitude, latency, phase, and reproducibility
3.5 Instrumentation of SOAE

3.6 Recording of SOAE

3.7 Synchronized SOAE

3.8 Factors affecting SOAE

3.9 SOAE & tinnitus

3.10 Clinical applications of SOAE

3.11 Suppression of SOAE

**Unit 4: Evoked oto-acoustic emission 18 Hrs**

4.1 Instrumentation of TEOAE/DPOAE /SFOAE

4.2 Techniques for recording TEOAE/ DPOAE/SFOAE

4.3 Factors affecting TEOAE/DPOAE/ SFOAE

4.4 Fine structure DPOAEs

4.5 Evoked OAEs & tinnitus

4.6 Clinical applications of TEOAE/ DPOAE /SFOAE

4.7 Contralateral & ipsilateral suppression of TEOAE/DPOAE/SFOAE: Procedure & applications

4.8 Implications in differential diagnosis and management

4.9 Research needs in OAEs

**Practicum:**

- Immittance evaluation
- Draw vector plots for
- middle system at resonance,
- mass dominated middle ear system
- Stiffness dominated middle ear system
- Measure admittance in the calibration cavities of various volumes and note down the observations
- Calculate Equivalent ear canal volume by measuring static admittance in an uncompensated tympanogram (10 ears)
- Record tympanogram in the manual mode and measure peak pressure, peak admittance and ear canal volume manually using cursor (5 ears).
- Interpret hypothetical case results indicating the presence of various middle ear pathologies (5 cases)
- Vary different stimulus and procedure related parameters and measure tympanogram to witness their effects. Few of the mandatory parameters are, probe tone frequency, rate of pressure change, direction of pressure change, number of trials, probe insertion depth, sneezing before measurement, speaking while measurement (5 ears)

- Carry out Acoustic reflex decay test and quantify the decay manually using cursor (5 individuals).
- OAEs
- Setting protocol for recording TEOAEs and DPOAEs
- Record TEOAEs, SFOAE, SOAE and DPOAE and note down the amplitude, SNR, noise floor and reproducibility at octave and mid-octave frequencies. Note down the stimulus stability and the overall SNR (3 ears each).
- Record ipsilateral and contralateral suppression of TE and DPOAEs and note down the suppression magnitudes

**References:**

**Unit 1 & 2: Tympanometry, Reflexometry**


1. Gelfand, S. A. (2009). *Essentials of Audiology*. New York: Thieme Medical Publishers.
2. Feldman, A. S., & Wilber, L. A., (1976). Acoustic immitance & admittance. Baltimore: Williams & Wilkins Com.
3. Jerger, J. (1975). Hand book of clinical impedance audiometry. Hudson, New Hampshire: American Publisher Electromedics Corp.
4. Silman, S., & Silverman, C.A. (1991). Auditory Diagnosis: Principles & Applications. San Diego: Academic Press.
5. Wiley, T.L., & Fowler, C.G. (1997). *Acoustic immittance measures in clinical audiology: A primer.* San Diego: Singular Publishing Group Inc.
6. Hunter, L., & Shahnaz, N. (2013). *Acoustic Immittance Measures: Basic and Advanced Practice* (1st Edn). San Diego: CA: Plural Publishing.
7. Katz, J., Medwetsky, L., Burkard, R. F., & Hood, L. J. (Eds.). (2007). *Handbook of Clinical Audiology* (6th revised North American edition). Philadelphia: Lippincott: Williams and Wilkins.
8. Musiek, F. E., & Rintelmann, W. F. (1999). *Contemporary Perspectives in Hearing Assessment*. Boston: Pearson.
9. Roeser, R. J., Valente, M., & Hosford-Dunn, H. (2007). *Audiology: Diagnosis*. New York: Thieme Medical Publishers.


**Unit 3: Oto-acoustic emissions, evoked oto-acoustic emission**


1. Berlin, C.I. (Ed.) (1996). *Hair cells and hearing aids*. London: Singular Publishing Group.
2. Berlin, C. I., Hood, L. J., & Ricci, A. (2002). Hair Cell Micromechanics and Otoacoustic Emissions. New York: Thomson Learning Inc.
3. Hall, J. W. (2000). Handbook of Otoacoustic Emissions. San Diego: Singular Publishing Company.
4. Musiek, F. E., & Rintelmann, W. F. (1999). Contemporary Perspectives in Hearing Assessment. Boston: Allyn and Bacon.

5. Robinette, M. S., & Glattke, T. J. (2007). Otoacoustic Emissions: Clinical Applications (3rd Edn). New York: Thieme Medical Publishers,.
6. Roeser, R. J., Valente, M., and Dunn, H. H. (2007). Audiology: Diagnosis. New York: Thieme Medical Publishers.
7. Christopher, A. Shera (2004) Mechanism for mammalian OAE and their implication for the clinical utility of OAE. *Ear & Hearing*, Vol.25, No.2, 86-97.
8. Joint Committee on Infant Hearing. (2007). Year 2007 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs. *Pediatrics*, 120, 898-921.
9. Hall, J. W., & Sumitrajit, D. (2010). *Otoacoustic Emissions: Principles, Procedures, and Protocols* (1st Edn). San Diego: Plural Publishing Inc.

**Unit 4: Evoked oto-acustic emission**

1. Shera, C.A., & Guinan, J.J. Jr. (1999) Evoked otoacoustic emissions arise by two fundamentally different mechanism: A taxonomy for mammalian cochlea. *JASA*, 105 (2), 782-98.
2. Sahley, T.L., Nodeer, R.H., & Musiek, F.E. (1997). *Efferent auditory system: Structure and function.* San Diego: Singular Publishing Group Inc.
3. Kemp, D. T. (1978). Stimulated acoustic emissions from within the human auditory system. *Journal of Acoustical Society of America*, 64, 1386-1391.
4. Mills, D. M., & Rubel, E. W., (1994). Variation of distortion product otoacoustic emissions with furosemide injection, Hearing Research, 77, 183-199

**Common**

1. Katz, J. (Ed.). (1994). *Handbook of Clinical Audiology*. Baltimore: Williams and Wilkins.
2. Hall, J.W., & Mueller, H.G. (1997) *Audiologists' Desk Reference* Volume 1: Diagnostic Audiology Principles, Procedures and Protocols. San Diego: Singular Publishing Group.
3. Rintleman, W.F. (1991). *Hearing Assessment*. Boston: Allyn and Bacon.
4. Roser, R.R., Valente, M., & Hosford-Dunn, D (Eds.) (2000*). Audiology: Diagnosis,* New York, Thieme.
5. Van De Water, T.R., Popper, A.N., & Fay, R.R. (Ed) (1996). *Clinical aspects of hearing.* New York: Springer

## Paper Code: AUD 1.4 a - SC: Auditory Physiology

**Objectives**

**After going through this subject, the student shall be able to describe:**

1. The different parts of the peripheral auditory system and vestibular system
2. The functioning of normal peripheral auditory system and vestibular system
3. The methods used to study auditory physiology
4. Give insights into the physiological basis of physiological tests used for hearing assessment
5. Applying the knowledge of auditory physiology to take appropriate clinical decisions

**Unit 1: Conductive mechanism of auditory system 18 Hrs**

1.1 External Ear: Anatomy and physiology
- Role of Pinna & External auditory meatus in hearing.
- Resonance properties of external ear in humans.

1.2 Role of head in localization.

1.3 Role of skull in bone conduction

1.4 Middle ear: Anatomy & Physiology of and humans
- Middle ear transformer action
- Concept of acoustic impedance
- Acoustic and non acoustic reflex pathways
- Anatomy & physiology of the Eustachian tube

**Unit 2: Anatomy of the sensory auditory system 18 Hrs**

2.1 Macro & microanatomy

2.2 Cochlear fluids origin, composition, absorption, and dynamics

2.3 Blood supply of inner ear

2.4 Innervations of inner ear

2.5 Cochlear regeneration

2.6 Auditory system in lower animals

**Unit 3: Physiology of the sensory auditory system 18 Hrs**

3.1 Basilar membrane mechanics -historical and current status.

3.2 Cochlear transduction **and** electrophysiology

3.3 Cochlear potentials their generation and properties.

3.4 Cochlear non-linearity - two tone suppression, otoacoustic emission & other recent advances.

3.5 Nutrients related to sensory cell physiology

3.6 Physiology of auditory system in non mammalian species

**Unit 4: Vestibular system 18 Hrs**

4.1 Anatomy and physiology of peripheral vestibular system
- Semicircular canals
- Utricle
- Saccule
- Vestibular nerve

4.2 Anatomy of the central vestibular pathway and its connections
- Brainstem
- Cerebellum
- Vestibular cortex

4.3 Reflexes involving the vestibular system
- Vestibulo-ocular reflex- pathways from each of the semicircular canals, cranial nerves involved (cranial nerves II, IV and V)
- Vestibulospinal reflex
- Sacculocollic reflex

4.4 Other systems involved in balance
- Proprioceptive (somatosensory) system- location of various receptors, strategies used for maintaining balance like ankle, hip, and step strategies
- Visual system- Various kinds of eye movements like gaze, saccade, optokinetic and pursuit

4.5 Association between vestibular system and cognition

**Practicum:**

1. Measure head related transfer function on 5 individuals
2. Measure the ear canal SPL and spectrum from different azimuths of sound
3. Measure non acoustic reflex on 5 individuals
4. Measure non linearity in auditory system using
   - Loudness growth function
5. OAEs

**Reference:**

**Unit 1: Conductive mechanism of auditory system**

1. Beagly, H. A. (1981). Audiology & Audiological medicine. Oxford: Oxford University Press.
2. De Reuck, A. V. S. & Knight, J. (1968). Hearing mechanisms in vertebrates. London: Churchill.

3. Gelfand, S. A. (2004). Hearing: Introduction to Psychological and Physiological Acoustics. (4th Edn.). New York: Marcel Decker.
4. Guinan, J. J., & Peake, W. T. (1967). Middle ear characteristics of anesthetized cats. *Journal of Acoustical Society of America, 41, 1237-61.*
5. Gulick, W. L., & Others. (1989). Hearing: Physiology, acoustics, neural coding & psychoacoustics. New York: Oxford University Press.
6. Jahn, A. F., & Santos-Sacchi, J. (1989). Physiology of the Ear. New York: Academic Press.
7. Keidel, W. D. & Neff, W. D. (1974). Handbook of Sensory Physiology. Berlin: Springer.
8. Kiyofumi, G. I., Hiroshi, A., & Goode, R. L. (1987). Measurement of the ossicular vibration ratio in human temporal bone by use of a video measuring system. *Acta Otolaryngologica*, 103, 87-95.
9. Moller, A. R. (2000). Hearing: Its physiology and pathology. San Diego: Academic Press.
10. Zemlin, W. R. (1998). Speech & Hearing science: Anatomy & Physiology. Boston: Allyn & Bacon.

**Unit 2: Anatomy of the sensory auditory system**

1. Berlin, C. I. (1996). Hair cells and hearing aids. San Diego: Singular Publishing Group.
2. Brown, R. D., & Daigneault, E. A. (1981). Pharmacology of hearing. New York: John Wiley & Sons
3. Dallos, P. (1973). Auditory periphery: Biophysics & physiology. New York: Academic Press.
4. Dallos, P., Popper, A. N., & Fry, R. R. (1996). The cochlea. New York: Springer.
5. De Reuck, A. V. S., & Knight, J. (1968). Hearing mechanisms in vertebrates. London: Churchill.
6. Moller, A. R. (2000). Hearing: Its physiology and pathology. San Diego: Academic Press.
7. Moore, B. C. J. (1995). Hearing. San Diego: Academic Press.
8. Zemlin, W. R. (1998). Speech & Hearing Science: Anatomy & Physiology. Boston: Allyn & Bacon.

**Unit 3: Physiology of the sensory and auditory system**

1. Altschuler, R. A., & Hoffman, D. W. (1986). Neurobiology of hearing: the cochlea. New York: Raven Press.
2. Berlin, C. I. (1996). Hair cells and hearing aids. San Diego: Singular Publishing Group.

3. Brown, R. D., & Daigneault, E. A. (1981). Pharmacology of hearing. New York: John Wiley & Sons.
4. Dallos, P., Popper, A. N., & Fry, R. R. (1996). The cochlea. New York: Springer-Verlag.
5. Dong, W., & Olsen, E. S. (2008). Supporting evidence for reverse cochlear travelling waves. *Journal of Acoustic Society of America*. 123, 222-240.
6. Drescher, D. G. (1985). Auditory biochemistry. Springfield: Charles C. Thomas.
7. Flock, A., Ottoson, D., & Ulfendahi, M. (1995). Active hearing. Baltimore: Williams & Wilkins.
8. Gelfand, S. A. (2004). Hearing: Introduction to Psychological and Physiological Acoustics. (4th Edn.). New York: Marcel Decker.
9. Gummer, A. W., Johnstone, B. M., & Armstrong, N. J. (1981). Direct measurement of basilar membrane stiffness in the guinea pig. *Journal of Acoustical Society of America*, 70, 1298-1309.
10. Hudspeth, A. J. (1985). The cellular basis of hearing: The biophysics of hair cells. *Science*, 230, 745-752.
11. Jahn, A. F., & Santos-Sacchi, J. (1989). Physiology of the Ear. New York: Academic Press.
12. Kemp, D. T. (1986). Otoacoustic emissions, travelling waves, and cochlear mechanisms. *Hearing Research*. 22, 95-104.
13. Moller, A. R. (2000). Hearing: Its physiology and pathology. San Diego: Academic Press.
14. Rubels, L., & Ruggero, M. A. (2001). Mechanics of mammalian cochlea. Physiological Reviews. 81, 1305-52.
15. Robinette, M. S., & Glattke, T. J. (1997). Otoacoustic emissions: clinical applications. New York: Thieme Medical Publications.
16. Zemlin, W. R. (1998). Speech & Hearing Science: Anatomy & Physiology. Boston: Allyn & Bacon.

**Unit 4: Vestibular system**

1. Bradford, L. J. (1975). Physiological measures of the audio-vestibular system. New York: Academic Press.
2. Furman, J. M., & Cass, S. P. (2003). Vestibular disorders. Oxford: Oxford University Press.
3. Gelfand, S. A., (2004). Hearing: Introduction to Psychological and Physiological Acoustics. (4th Edn.). New York: Marcel Decker.
4. Jackler, R. K., & Brackmann, D. E. (2005). Neuro-otology. New York: Elsevier Mosby.
5. Nauton, R. F. (1975). The vestibular system. New York: Academic Press.

## Paper Code: AUD 1.4 b - SC: Technology for Speech-Language & Hearing

**Objectives**:-

**After successful completion of the course student should be able to:**

1. Give an overview of the latest technology involved in speech acoustics, signal processing and instrumentation.
2. Provide fundamental concepts of the technology used in the instruments for diagnostics and therapeutics in Audiology, Speech Language Sciences and Pathology
3. Understand the basic technology used in hearing aids & cochlear implants.
4. Understand the principle of working and utility of equipment used for measurement of sound and calibration of diagnostic equipment.
5. Perform calibration of diagnostic instruments.
6. Lay the foundation of Information and Communication Technology (ICT) concepts and illustrate its applications in *Audiology*, Speech & Language Sciences & Pathology.

### Unit 1: Transducers, signal processing components & power supply 12 Hrs

1.1 Transducers used in speech, language and hearing

- Microphones: Basic structure & principle of operation of dynamic, condenser and electret microphones.
- Essential characteristics of microphones for recording, speech analysis and speech audiometry
- Loudspeakers: Basic structure & principle of operation of dynamic loudspeaker, moving coil and balanced armature type receivers
- Essential characteristics of headphones and insert receivers used in audiology

1.2 Signal Processing components

- Role of preamplifiers and power amplifiers
- Filters: Types and their role

1.3 Power supply

- Requirements for mains supply to clinics
- Internal power supply of instruments
- Uninterrupted power supply for entire clinic vs. individual instruments

### Unit 2:Introduction to digital signal processing and information & communication technology 12 Hrs

2.1 Digital signal processing

- Basic structure of a digital signal processing system
- Process of analog to digital conversion

- Process of digital to analog conversion
- Basic concepts of digital signal processing: decomposition, processing and synthesis
- Implementation of signal processing functions using DSP

2.2 Information technology

- Introduction to computer architecture
- Role of operating systems
- Role of RAM and hard disk
- Structure and functioning of computer networks

2.3 Communication technology

- Frequency modulation & its applications in group hearing aids
- Basic structure of a satellite communication system
- Concept of world wide web
- Basic structure of internet connectivity
- Tele-diagnosis & tele-rehabilitation system.

**Unit 3: Technology involved in hearing aids, cochlear implants and speech processing & analysis 15 Hrs**

3.1 Technology involved in hearing aids

- Basic technology of a digital hearing aid
- Technologies for non-linear amplification
- Technologies for noise suppression
- Technologies for feedback cancellation

3.2 Technology involved in cochlear implants

- Basic architecture of a cochlear implant
- Basic technology of speech processor

3.3 Fundamentals of speech signal processing

- Representing a speech signal in time domain
- Converting from time domain to frequency domain
- Short time analysis techniques

3.4 Techniques of speech analysis & applications

- LPC analysis
- Cepstrum analysis
- Speaker recognition
- Speech synthesis
- Speech to text conversion

**Unit 4: Instrumentation in audiology, speech & language 15 Hrs**

4.1 Instrumentation in speech & language

- Speech spectrograph and computerised analyses of speech

- Voice analyses systems
- Electroglotograph
- Articulograph
- Nasometer
- Fibre optic endoscope

4.2 Instrumentation in audiology

- Audiometer
- Middle ear analyzer
- Otoacoustic emission analyzer
- Instrumentation for auditory evoked potentials
- Multichannel EEG and ERP systems
- Equipment and components used for measurement of sound and calibration

4.3 Room acoustics, measurements & electric grounding

- Noise auditing
- Measurement of reverberation time
- Audiometric test room
- Recording room
- Procedure to make a perfect electric ground

4.4 Fundamentals of imaging technology

- X-Ray
- C-Arm
- CT scan
- MRI
- fMRI
- PET
- SPECT

**Practicum:**

1. Observe the operation of transducers.
2. Measure sound & noise
3. Calibration of audiometer/EGG
4. Measurement of reverberation time & ambient noise
5. Checking electrical grounding

**References:**

**Unit 1: Transducers, signal processing components & power supply**

1. Crocker, M.J. (1998). *Handbook of Acoustics.* New York: John Wiley & Sons, Inc.,
2. Rossing, T.D. (2002). *The Science of Sound. 3rd Edn.,* Glenview: Pearson Education, Inc.,

3. Vonlanthen, A. (2007). *Hearing Instrument Technology for the Hearing Health Care Professionals*. London: Singular Publishing Group
4. Dillon, Harvey (2001). *Hearing Aids*. New York: Thieme Medical Publications.
5. Katz, J. (2009). *Handbook of Clinical Audiology 6th Edn*. Philadelphia: Wolters Kluwer.

**Unit 2: Introduction to digital signal processing and information & communication technology**

1. Nagpal, D. P. (2009). *Computer Fundamentals: Concepts, Systems and Applications.* New Delhi: S. Chand and Company.
2. Malvino, A. P. (1979). *Digital Computer Electronics.* Bombay: Tata McGraw Hill.
3. Kennedy, B. (1993). *Electronic Communiation Systems.4th Edn.* Bombay: Tata McGraw Hill.
4. Hersh, M. A., & Johnson, M.A. (2003). *Assistive Technology for the Hearing Impaired Deaf and Deaf-blind.* London: Springer
5. Tan, Li Jiang. (2013). *Digital Signal Processing: Fundamentals and Applications 2nd ed.* New York: Academic Press Inc

**Unit 3: Technology involved in hearing aids, cochlear implants and speech processing & analysis**

1. Schaub, Arthur. (2008). *Digital Hearing Aids.* New York: Thieme Medical Publishers Inc.
2. Niparko, John K. (2009). *Cochlear implants - Principles and Practices* - 2nd Edn. New York: Lippincott Williams & Wilkins
3. Valente, Michael. (2002). *Hearing Aids: Standards, Options and Limitations*: Thieme Medical Publishers.
4. Sandlin, R.E. (2002). *Handbook of Hearing Aid Amplification, Vol. I: Theoretical and Technical Considerations,* London : Singular Publishing Group, Inc.

**Unit 4: Instrumentation in audiology, speech & language**

1. Kent, R. D. (1995). *The Acoustic Analysis of Speech,* Delhi: AITBS Publishers, Inc.
2. Khandpur, R.S. (1993). *Hand Book of Bio-Medical Instrumentation*. Bombay: Tata Mcgraw Hill
3. Jacobson, John T. (1985). *Auditory Brainstem Response*. London: Taylor and Francis Ltd.
4. Hall, James W. (2000). *Handbook of Otoacoustic Emissions*. New York : Delmar Cengage Learning.
5. Katz, J. (2009). *Handbook of Clinical Audiology. 6th Edn*. Philadelphia: Wolters Kluwer.

## Paper Code: AUD 1.5 a - SC: Diseases of the Ear and Auditory Pathway

**Objectives: After successful completion of the course student will**

1. Understand clinical anatomy and physiology of the auditory system
2. Obtain knowledge about the pathophysiology of diseases related to the ear.
3. Have a holistic view about assessment and management of audio vestibular problems.

### Unit 1: Anatomy and physiology of the auditory system 12 Hrs

1.1 Anatomy: External ear, mild ear and inner ear (labyrinth, cochlea, organ of corti, vascular supply of the ear, vestibulocochlear nerve), central auditory pathways and its connection.

1.2 Structure and function of nervous system: Central and peripheral nervous system, synapse and chemical mediators, circle of willis, cerebral cortex in hearing, cranial nerves.

1.3 Neurophysiology: Action potential, summating potential, neuromuscular junction, CSF, central auditory pathway and its disorders

### Unit 2: Diseases of the external and middle ear 18 Hrs

2.1 Congenital malformations,

2.2 Diseases of the external ear: Otitis – externa, neoplasms of external ear, cerumen, keratosis obturans, injuries, sebaceous cysts, acquired atresia , stenosis of external auditory canal & malignant otitis externa

2.3 Diseases of the middle ear cleft: Otosclerosis otitis media, non suppurative otitis media, ,complications of middle ear diseases, neoplasms.

2.4 Diseases of the Otic capsule: Menieres disease, injuries, miscellaneous conditions of the otic capsule, CP angle tumor, trauma, inflammatory conditions, presbyacusis, NIHL, sudden SNHL central deafness,

2.5 Reconstruction of middle ear hearing mechanisms: Reconstructive and rehabilitation procedures

### Unit 3: Diseases of the cochlea 12 Hrs

3.1 Ototoxicity: Cochleotoxic and vestibule- toxic drugs and its effects,

3.2 Anatomical and physiological correlates in ototoxicity, epidemiology and mechanism

3.3 Systemic toxicity, topical toxicity, interventions, therapeutic uses of ototoxic drugs and pharmacology related to it

3.4 Medico-legal issues.

**Unit 4 Vestibular system 12 Hrs**

4.1 Medical and surgical management of problems of ear causing communication disorders
4.2 Vestibular system: Medical, surgical, rehabilitative management

**Practicum:**

Observation of the following:

- ENT examination of
  - History taking
  - Diagnostic procedures
  - Microscopic examination & procedures
  - Otoscopy / Otoendoscopy
  - Equipments & instruments
  - Vertigo
- Various pathological conditions of the ear
- Surgical procedures in operation theatre Log book maintenance & submission

**References:**

**Unit 1: Anatomy and physiology of the auditory system**

1. Gleeson, M. J., & Clarke, R. C. (2008). Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7th Ed: 3 volume set: CRC Press.
2. Dhingra, P.L (2013 Diseases of Ear, Nose and Throat. New Delhi: Elseveir
3. Blair, R and Maran A.D.G. (2001). Long Turners Diseases of Ear, Nose and Throat. Hodder Arnold
4. English, G.M. (1976). Otorhino-laryngology a text book. Michigan: Medical Department Harper and Row
5. Standring, S. (2008). Gray's Anatomy: The Anatomical Basis of Clinical Practice, Expert Consult. Livigstone: Churchill publishers.

**Unit 2: Diseases of the external and middle ear**

1. Gleeson, M. J., & Clarke, R. C. (2008). Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7th Ed: 3 volume set: CRC Press.
2. Dhingra, P.L (2013 Diseases of Ear, Nose and Throat. New Delhi: Elseveir
3. Blair, R and Maran A.D.G. (2001). Long Turners Diseases of Ear, Nose and Throat. Hodder Arnold
4. English, G.M. (1976). Otorhino-laryngology a text book. Michigan: Medical Department Harper and Row
5. Standring, S. (2008). Gray's Anatomy: The Anatomical Basis of Clinical Practice, Expert Consult. Livigstone: Churchill publishers.

**Unit 3: Diseases of the cochlea**

1. Gleeson, M. J., & Clarke, R. C. (2008). Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7th Ed: 3 volume set: CRC Press.
2. Dhingra, P.L (2013 Diseases of Ear, Nose and Throat. New Delhi: Elseveir
3. Blair, R and Maran A.D.G. (2001). Long Turners Diseases of Ear, Nose and Throat. Hodder Arnold
4. English, G.M. (1976). Otorhino-laryngology a text book. Michigan: Medical Department Harper and Row
5. Standring, S. (2008). Gray's Anatomy: The Anatomical Basis of Clinical Practice, Expert Consult. Livigstone: Churchill publishers.

**Unit 4: Vestibular system**

1. Weber, P.C. (2008). Vertigo and Disequilibrium: A Practical Guide to Diagnosis and Management. Thieme
2. Biswas, A. (2005). Introduction to Neurotology. Mumbai: Bhalani Medical book house

## Paper Code: AUD 1.5 b - SC: Clinical Counselling

**Objectives:**

***After successful completion of the course student will be***

1. Prepare in the specific area of clinical counselling to understand counsellor-client relationships in the context of training and rehabilitation of individuals with communication disorders.
2. Trained in practical skills and competencies required for mastering basics of clinical counselling for identification and management of persons with communication disorders.
3. Sensitized on the ethical aspects of clinical counselling.
4. Able to integrating counselling based aspects in the field of research in communication disorders.

**Unit 1: Introduction 18 Hrs**

1.1 Guidance and Counselling: Meaning, Nature, Scope, Principles and Goals

1.2 Types and Techniques: Individual and group with special focus on need and applications of clinical counselling

1.3 Counselling across life span: Child, Adolescent, Parenthood, Sibling, Grandparent/Elderly;

1.4 Counselling across Relationships: Teacher, family and peer Group

**Unit 2: Counsellor qualities 18 Hrs**

2.1 Portrait of Effective Counsellors: Qualifications and Qualities, Micro and macro skills and competencies

2.2 Do's and Don'ts; Expectations and Limitations in Professional Clinical Counselling

2.3 Tips for Improvement

2.4 Ethical Issues

**Unit 3: Counselling process 18 Hrs**

3.1 Counselling Process: Stages in Clinical Counselling

3.2 Preparation and Pre-requisites: Middle Phase, Termination

3.3 Therapeutic Relationships

3.4 Principles in Clinical Practice: Directive and Non-Directive approaches

3.5 Tools for Clinical Counselling

3.6 Major Events (Transference, Counter Transference & Resistance)

**Unit 4: Special areas 18 Hrs**

4.1Special Areas in clinical counselling: Counselling the differently abled, parents, sibling and grandparents and significant others

4.2 Counselling: Crisis counselling, gender counselling, human rights,

4.3 Enablement and empowerment through counselling

4.4 Counselling the elderly & psychiatric patients

**Practicum:**

1. Direct observation and thematic recording of at least two sessions of professional individual counselling.
2. Notes taking of group counselling session.
3. Eliciting counselling needs of target groups.

**Reference:**

**Title: Fundamentals of Clinical Counselling**

**Unit 1: Introduction**

1. Gelso, C.J., & Fretz, B.R. (1995). *Counselling Psychology*. New Delhi: A Prism Indian Edition.
2. Hansen, J.C., Stevic, R.R., & Warner, R.W. (1987). *Counselling*. Boston: Allyn & Bacon, Inc.,
3. Nelson-Jones, R. (1999). *Introduction to Counselling Skills*. London: Sage Publications.
4. Rao, N.S. (1981). *Counselling Psychology*. New Delhi: Tata McGraw Hill Pub. Co.
5. Palmer, S., Dainow, S., & Milner, P. (1996). *Counselling*. London, Sage Pubs.
6. Shertzer, B.S., & Stone, B. (1968). *Fundamentals of Counselling*. NY: Houghton Mifflin Co.
7. *Neukrug, E. (2015). The world of counsellor: an introduction to counselling profession. Boston: Cengage Learning.*
8. *Capuzzi, D., & Gross, D.R. (Eds.). (2013). Introduction to counselling program. New York: Routledge.*

**Unit 2**: **Counsellor qualities**


1. Street, E. (1994). *Counselling for Family Problems*. London, Sage Publications.
2. Blackham, G.J. (1977). Counselling – Theory, Process & Practice. Belmont: Wadsworth.
3. Palmer, S. (1999). *Introduction to Counselling and Psychotherapy*. London: Sage Publications.
4. Corey, G. (2011). Theory and practice of group counselling. 8th Edition. California: Brooks/Cole Publishing Company.
5. Corey, G. (2001). *The art of integrative counselling.* Pacific Grove, CA: Brooks/Cole.
6. *Gladding, S.T. (2009). Counselling: a comprehensive profession. New Delhi: Dorling Kindersley (India) Limited.*
7. *Corey, G. (2013). Student manual for Corey's theory and practice of counselling and psychotherapy. Boston: Cengage Learning.*


**Unit 3: Counselling process**


1. Nelson-Jones, R. (1982). *The Theory and Practice of Counselling Psychology*. London: Holt, Rinehart and Wilson.
2. Corey, G. (2008). Theory and practice of counselling and psychotherapy. California: Brooks/Cole.
3. Corey, G., Corey, C., & Corey, M.S. (2008). Groups: Process and Practice. California: Brooks/Cole.
4. *Woolfe, R., Strawbridge, S., Douglas, B., & Dryden, W. (2010). Handbook of counselling psychology. New Delhi: Sage Publications.*
5. *Daley, D.C., & Zuckoff, A. (1999). Improving treatment compliance: counselling and systems strategies for substance abuse and dual disorders. Minesota: Hazelden.*
6. *Welfel, E.R. (2004). The counselling process: a multi-theoretical integrative approach. Pacific Grove, CA: Thomas/Brooks/Cole.*
7. *Bradly, L.J., & Ladany, N. (2001). Counsellor supervision: principles, process, and practice. Philadelphia: Brunner-Routledge.*


**Unit 4: Special areas**


1. Jacobs, Ed. E., Masson, R.L., & Harvill, R.L. (1998). *Group Counselling: Strategies & Skills*. Pacific grove, CA: Books/Cole Pub. Co.,
2. Madden, G.R. (1998). *Legal Issues in Social Work: Counselling and Mental Health*. Thousand Oaks: Sage.
3. Thomas, R.M. (1990). *Counselling and Life-span development*. New Delhi: Sage.
4. Tudor, K. (1998). *Group Counselling*. London: Sage.

5. *Hart, JT (1983). Modern eclectic therapy a functional orientation to counselling and psychotherapy. New York: Plenum.*
6. *Maki, D.R., & Tarvydas, V.M. (2011). The professional practice of rehabilitation counselling. New York: Springer.*
7. *Toporek, L., Gerstein, L., Fouad, N., Roysircar, G., & Isreal, T. (2006). Handbook of social justice in counselling psychology. New Delhi: Sage.*
8. *Gazda, G.M. (1989). Group Counselling. Boston: Allyn & Bacon.*
9. *Ivey, A.E. (1998). Intentional interviewing and counselling: facilitating client development in a multicultural society. New York: Wadsworth.*

## Paper Code: AUD 1.6 - HCC: Clinical Practicum I

## II SEMESTER
## Paper Code: AUD 2.1 - HC: Psychophysics of Audition

**Objectives:**

**After completion of the course, the student should be able to:**

1. Explain the basis of auditory object perception.
2. Explain the influence of stimulus on auditory system with reference to adaptation and fatigue.
3. Understand and describe different aspects of auditory space perception.
4. Clinically implement the concept of binaural hearing in audiological assessment and management.

**Unit 1: Auditory scene analysis 18 Hrs**

1.1 Auditory object perception in individuals with normal hearing and those with hearing impairment
- Basic concepts in auditory object perception
- Spectral cues for object perception
  - Spectral separation
  - Spectral profile analysis
- Temporal cues for object perception
  - Temporal separation
  - Harmonicity/Temporal regularity
  - Temporal onset and offset

1.2 Auditory pattern perception in individuals with normal hearing and those with hearing impairment
- Timber perception
- Time invariant-pattern and time varying pattern perception

**Unit 2:** Space perception in individuals with normal hearing and those with hearing impairment 18 Hrs

2.1 Localization of pure-tones
- Cues for localization
- Cone of confusion
- Time-intensity trading

2.2 Localization of complex tones
- Cues for localization
- Acuity of lateralizing transients
- Acuity as a function of frequency and use of envelope
- Onset disparities vs. ongoing disparities
- Time-intensity trading

**Unit 3**: Binaural hearing in individuals with normal hearing and those with hearing impairment 18 Hrs

3.1 Models of binaural hearing in normal hearing individuals
3.2 Binaural hearing
- Binaural Squelch effect
- Sluggishness of binaural system
- Binaural fusion of pulsed stimuli
- Binaural beats
- Binaural interference
- JND for dichotic phase

3.3 Masking level difference
- Pure tones
- Complex signals

**Unit 4:** uditory adaptation in individuals with normal hearing and those with hearing impairment 18 Hrs

4.1 Adaptation vs. fatigue
4.2 Methods of studying adaptation
4.3 Binaural adaptation
4.4 Neurophysiological basis of adaptation
4.5 Factors affect adaptation
- Subject
- Stimulus
- Procedural

**Practicum:**

Psychoacoustic Practicum

1. Measuring binaural fusion for pulsed stimuli on 3 individuals with normal hearing.
2. Measuring JND for dichotic phase on 3 individuals with normal hearing.
3. Measuring masking level difference for pure-tone and complex signals on 3 individuals each with normal hearing

**References:**

**Unit 1: Auditory scene analysis**


1. Bregman, A. S. (1994). Auditory Scene Analysis. The Perceptual Organization of Sound: MIT Press.
2. Gelfand, S.A. (2004). Hearing. An introduction to psychological and physiological acoustics. 4th Edn. New York: Marcel Dekker.
3. Moore, B. C. J. (1995). Hearing, San Diego: Academic Press.
4. Moore, B. C. J. (1997). Introduction to psychology of hearing. San Diego: Academic Press.
5. Moore, B. C. J. (2008). Cochlear hearing loss: physiological, psycho-logical and technical issues. 2nd Ed. Wiley-Blackwell.
6. Pillow, J. (2009). Hearing in the Environment: Perception (PSY 323). Austin: The University of Texas.
7. Warren, R. M. (2008). Auditory Perception: An Analysis and Synthesis. Cambridge: Cambridge University Press.
8. Yost, W. A. (1994). Fundamentals of hearing (all editions). CA: Academic Press Inc.


**Unit 2: Space perception in individuals with normal hearing and those with hearing impairment**


1. Gelfand, S, A. (2005). Introduction to psychological and physiological acoustics. NY: Marcel Dekker.
2. Gullick, W. L., Gescheider, G. A., & Frisina, R. D. (1989). Hearing: Physiology Acoustics, Neural Coding & Psychoacoustics. OUP USA.
3. Moore, B. C. J. (1995). Hearing. San Diego: Academic Press.
4. Moore, B. C. J. (1997). Introduction to psychology of hearing, San Diego: Academic Press.
5. Pickles, J.O. (2008). Introduction to Physiology of Hearing. New York: Academic Press.
6. Tobias, V. J. (1970). Foundation of Modern Auditory Theory, San Francisco: Academic Press.
7. Warren, R. M. (2008). Auditory Perception: An Analysis and Synthesis. Cambridge: Cambridge University Press.
8. Yost, W. A. (1994). Fundamentals of hearing: An introduction. San Diego, Academic Press.
9. Yost, W. A., & Gourevitch, G. (1987). Directional Hearing, New York: Springer-Verlag.


**Unit 3: Binaural hearing in individuals with normal hearing and those with hearing impairment**


1. Gelfand, S.A. (2004). Hearing. An introduction to psychological and physiological acoustics. 4th Edn. New York: Marcel Dekker.
2. Jerger, J. (1973). Modern developments in Audiology. 2nd Edn. New York. Academic Press.

3. Loven, F. (2009). Introduction to normal auditory perception. Singapore: Delmar Cengage Learning.
4. Rosen, S., & Howell, D. (1991). Signals and systems for speech and hearing. CA: Academic Press Inc.
5. Tobias, J. V. (1970). Foundation of modern auditory theory. Volume I. New York: Academic Press.

**Unit 4: Auditory adaptation in individuals with normal hearing and those with hearing impairment**

1. Gelfand, S. A. (2004). Hearing. An introduction to psychological and physiological acoustics. 4th Edn. New York: Marcel Dekker.
2. Jerger, J. (1973). Modern developments in Audiology. 2nd Edn. New York: Academic Press.
3. Loven, F. (2009). Introduction to normal auditory perception. Singapore: Delmar Cengage Learning.
4. Rosen, S., & Howell, D. (1991). Signals and systems for speech and hearing. CA: Academic Press Inc.
5. Tobias, J. V. (1970). Foundation of modern auditory theory. Volume I. New York: Academic Press.
6. Tobias, J. V. (1983). Foundations of modern auditory theory. Vol. II, New York: Academic Press.
7. Yost, A. W., Popper A. N., & Fay, R. R. (2008). Auditory Perception of Sound Sources. Chicago: Springer-Verlag.
8. Yost, W. A. (1994). Fundamentals of hearing (all editions). CA: Academic Press Inc.

## Paper Code: AUD 2.2 - HC: Electrophysiological Assessment of the Auditory System

### Objectives

After completion of this course, students should be able to

1. Describe different auditory evoked potentials (AEPs), **their clinical applications** and generators **sites.**
2. Describe general principles in recording various AEPs
3. Independently decide the need for recording a particular AEP in a clinical set-up.
4. Independently set the parameters for recording and analyzing various AEPs.

### Unit 1: General principle in recording of AEPs 18 Hrs

1.1 Stimuli for recording AEPs.

1.2 Acquisition of EEG signal
- Common mode rejection
- A/D conversion
- Amplification
- Antialasing filter
- Dipole orientation and scalp distribution

1.3 Signal processing techniques
- Analog filters & digital filters
- Time locked acquisition
- Amplitude based techniques for artifact rejection
- Unweighted and weighted time domain averaging
- Unweighted and weighted frequency domain averaging

1.4 Rationale for nomenclature and generators of auditory evoked potentials

### Unit 2 Early potentials 18 Hrs

2.1 Electro-cochleograhy: Acquisition, analysis and application of
- Cochlear microphonics
- Summating potentials
- Action potentials

2.2 Auditory Brainstem Responses: Acquisition, analysis and application of
- Frequency specific ABRs using tone burst, chirp and masking methods
- Complex ABRs
- Stacked ABR

**Unit 3 Middle and late AEPs 18 Hrs**

3.1 Factors affecting MLR & LLR
- Stimulus
- Acquisition
- Subject

3.2 Clinical application of MLR and LLR

3.3 Acoustic change complex: Acquisition, analysis and application

3.4 Frequency following responses: Acquisition, analysis and application

3.5 Auditory steady state responses: Acquisition, analysis and application

3.6 VEMP & PAM : Acquisition, analysis and application

**Unit 4 Endogenous potentials 18 Hrs**

4.1 Overview of endogenous potentials

4.2 Acquisition, analysis, factors affecting and application of
- MMN
- $P_{300}$
- $N_{400}$
- $P_{600}$
- ELAN
- CNV
- Other endogenous potentials

4.3 Multi-modality stimulation

4.4 Special techniques involved in acquisition and analysis of endogenous potentials

**Practicum:**

1. Calibrating the transient stimuli used for ABR using objective and , MLR and LLR using objective and subjective methods
2. Recording Auditory Brainstem Responses to click, tone burst, chirp and speech stimuli and observing the effect of stimulus and acquisition parameters on the latency, amplitude and morphology of the responses.
3. Practicing diagnostic tests using Auditory brainstem responses, like hearing threshold estimation, site-of-lesion testing, cochlear hydrops analysis masking procedure and stacked ABR.
4. Recording the Auditory Middle latency responses and long latency responses to click, tone burst and speech stimuli, and observing the effects of stimulus and acquisition parameters on the latency, amplitude and morphology of the responses.
5. Recording the P300 and mismatch negativity to frequency, intensity and duration deviance in pure tones, and place manner and voicing contrasts in consonant

(stop) vowel combinations. Estimating hearing threshold using ABR, MLR and LLR on 5 children with normal hearing, 5 children with hearing loss, 5 adults with normal and 5 adults with hearing loss.

**References:**

**Unit 1: General principle in recording of AEPs**


1. Burkard, R.F., Don, M., & Eggermont, J.J. (Eds.) (2007). Auditory Evoked Potentials: Basic Principles & Applications. Baltimore: Lippincott Williams & Wilkins.
2. Ferraro, J.A. (1997). Laboratory exercises in auditory evoked potentials. San Diego: Singular Publishing Group Inc.
3. Picton, T. (2010). Human Auditory Evoked Potentials. San Diego: Plural Publishing.
4. Hall, J.W. (2007). New Handbook of Auditory Evoked Responses. Boston: Pearson.
5. Katz, J. (Ed.). (1994). Handbook of Clinical Audiology. Baltimore: Williams and Wilkins.
6. Roser, R.R., Valente, M., & Hosford-Dunn, D. (Eds.) (2000). Audiology: Diagnosis. New York: Thieme Medical Publishers.


**Unit 2:Early potentials**


1. Burkard, R.F., Don, M., & Eggermont, J.J. (Eds.) (2007). Auditory Evoked Potentials: Basic Principles & Applications. Baltimore: Lippincott Williams & Wilkins.
2. Hall, J.W. (1992). Handbook of Auditory Evoked Responses. Massachussetts: Allyn and Bacon.
3. Hall, J.W. (2007). New Handbook of Auditory Evoked Responses. Boston: Pearson
4. Hall, J.W., & Mueller, H.G. (1997) Audiologists' Desk Reference. Volume 1: Diagnostic Audiology Principles, Procedures and Protocols. San Diego: Singular Publishing Group.
5. Hood, L.J. (1998). Clinical applications of auditory brainstem response. San Diego: Singular Publishing Group Inc.
6. Roser, R.R., Valente, M., & Hosford-Dunn, D. (Eds.) (2000). Audiology: Diagnosis. New York: Thieme Medical Publishers.
7. Sininger, Y., & Starr, A. (2001). Auditory neuropathy: A new perspective on hearing disorders. Singular Publications.
8. Picton, T. (2010). Human Auditory Evoked Potentials. San Diego: Plural Publishing Group.

**Unit 3: Middle and late AEPs**


1. Burkard, R.F., Don, M., & Eggermont, J.J. (Eds.) (2007). Auditory Evoked Potentials: Basic Principles & Applications. Baltimore: Lippincott Williams & Wilkins.
2. Hall, J.W. (1992). Handbook of Auditory Evoked Responses. Massachussetts: Allyn and Bacon.
3. Hall, J.W. (2007). New Handbook of Auditory Evoked Responses. Boston: Pearson.
4. McPherson, L.D. (1995). Late potentials of the auditory system. London: Singular Publishing Group.
5. Roser, R.R., Valente, M., & Hosford-Dunn, D. (Eds.) (2000). Audiology: Diagnosis. New York: Thieme Medical Publishers.
7. McPherson, L.D. (1995). Late potentials of the auditory system. London: Singular Publishing Group.
8. Picton, T. (2010). Human Auditory Evoked Potentials. San Diego: Plural Publishing Group.


**Unit 4: Endogenous potentials**


1. Burkard, R.F., Don, M., & Eggermont, J.J. (Eds) (2007). Auditory Evoked Potentials: Basic Principles & Applications. Baltimore: Lippincott Williams & Wilkins.
2. Hall, J.W. (1992). Handbook of Auditory Evoked Responses. Massachussetts: Allyn and Bacon.
3. Hall, J.W. (2007). New Handbook of Auditory Evoked Responses. Boston: Pearson.
4. Katz, J. (Ed.). (1994). Handbook of Clinical Audiology. Baltimore: Williams and Wilkins.
5. McPherson, L.D. (1995). Late potentials of the auditory system. London: Singular Publishing Group.
6. Roser, R.R., Valente, M., & Hosford-Dunn, D. (Eds.) (2000). Audiology: Diagnosis. New York: Thieme Medical Publishers.
7. Picton, T. (2010). Human Auditory Evoked Potentials. San Diego: Plural Publishing Group.

## Paper Code: AUD 2.3 a - SC: Neurophysiology of Hearing

**Objectives:**

After going through this course, the student shall be able to describe:

1. The different parts of auditory afferent and efferent systems
2. The functioning of auditory afferent and efferent systems
3. The methods used in auditory neurophysiology
4. Physiological basis of electrophysiological tests used for hearing assessment
5. The neurophysiological basis of clinical interpretation

**Unit 1: Anatomy & physiology of the auditory nerve 18 Hrs**

1.1 Structure and tonotopic organization of auditory nerve

1.2 Electrophysiology - Action potential, generation and properties.

1.3 Physiology of the auditory nerve
- Stimulus coding - frequency, intensity and temporal coding.
- Coding of complex signal at the auditory nerve
- Non-linearity seen at auditory nerve.

1.4 Synapse
- Neuro-transmitters vs. neuro- modulator
- Properties and function of neuro-transmitter
- Afferent and efferent neuro-transmitters

1.5 Application of knowledge of auditory nerve physiology in understanding various auditory nerve disorders

**Unit 2: Central auditory pathway 18 Hrs**

2.1 Anatomy of the ascending auditory pathway
- Cochlear nucleus
- Superior olivary complex
- Lateral leminiscus
- Inferior colliculus
- Medial geniculate body
- Tonotopic organization at the different levels.

*2.2 Physiology of the ascending auditory pathway*
- Physiology of the cochlear nucleus
- Physiology of superior olivary complex
- Physiology of lateral leminiscus
- Physiology of inferior colliculus
- Physiology of medial geniculate body

- Coding of simple and complex acoustic signal at various sub cortical levels

**Unit 3: Auditory cortex 18 Hrs**

3.1 Anatomy and tonotopic organization of the primary and secondary auditory area.

3.2 Classifications of the auditory cortex

3.3 Neurobiological relationship between auditory cortex and other areas

3.4 Neurophysiology of the auditory area.
- Coding of the stimulus parameters.
- Coding of the complex acoustic signal
- Plasticity of the auditory system

3.5 Coding of speech in auditory system

3.6 Physiology of sound localization in the auditory system

**Unit 4: Anatomy & physiology of the efferent pathway & cranial nerves related to ear 18 Hrs**

4.1 Anatomy of the efferent auditory system
- Courses and distribution of MSOC in the cochlea
- Courses and distribution of LSOC in the cochlea
- Anatomy of the thalamic & upper brainstem efferent auditory system

4.2 Physiology of the auditory efferent system
- Effect of auditory efferent system on physiology of cochlear nucleus, auditory nerve and cochlea
- Role of auditory efferent system in perception of auditory stimuli.
- Protective function of auditory efferent system

4.3 Anatomy of non-classical auditory pathway

4.4 Anatomy of the other cranial nerves related to ear.

**Practicum:**

Observe specimens of various auditory structures and make notes of observations

**References:**

**Unit 1: Anatomy & physiology of the auditory nerve**

1. Musiek, F.E., & Baran, J.A. (2006). The auditory system: anatomy, physiology and clinical correlates. USA: Indiana University Press.

2. Jahn, A.F., & Santos-Sacchi, J. (2001). Physiology of the ear. San Diego: Singular/Thomson Learning.
3. Gelfand, S.A. (2004). Hearing: An introduction to psychological and physiological acoustics. USA: Marcel Dekker Inc.
4. Webster, D.B., Popper A.N., & Fay R.R. (1992). The Mammalian auditory pathway: neuroanatomy. New York: Springer-Verlag.
5. Webster, D.B., Popper, A.N., & Fay R.R. (1992). The Mammalian auditory pathway: neurophysiology. New York: Springer Link.
6. Pickels, J.O. (2012). An introduction to the physiology of hearing. United Kingdom: Emerald Group Publishing Inc.
7. Günter, E., & Romand, R. (1997). The central auditory system. United Kingdom: Oxford University Press.
8. Richard, A. (1991). Neurobiology of Hearing. USA: Raven Press.
9. Enrique A. & Lopez-Poveda,S. (2010). The neurophysiological bases of auditory perception. New York: Springer -Verlag.
10. Rees, A., & Palmer, A.R. (2010). The Oxford Handbook of Auditory science: The auditory brain. United Kingdom: Oxford University Press.
11. Moore, D., Palmer, A., & Fuchs, P. (2010). Oxford handbook of auditory science the ear. United Kingdom: Oxford University Press.
12. Schnupp, J., Nelken, I., & Andrew, K (2011). Auditory Neuroscience: Making Sense of Sound. USA: Library of Congress.
13. Musiek, F.E., Baran, J.A., Shinn, J., & Raleigh, J. (2012). Disorders of the Auditory System. San Diego: Plural Publishers.
14. Günter, E., & Romand, R. (1997). The central auditory system. United Kingdom: Oxford University Press.

**Unit 2: Central auditory pathway**

1. Douglas, B., Webster, N., Arthur N. & Richard R. (1992). The Mammalian auditory pathway: neuroanatomy. New York: Springer -Verlag.
2. Douglas, B. Webster, N., Arthur N. & Richard R. (1992). The Mammalian auditory pathway: neurophysiology. New York: Springer Link.
3. Anthony, F. J., & Santos-Sacchi, J. (2001). Physiology of the ear. San Diego: Singular/Thomson Learning.
4. Jeffery, A., & Schreiner, C. (2005). The inferior Colliculus. USA: Springer-Verlag.
5. Lambert, M.S., Miriam T. T, & Susan F. M (2010). Superior Olivary Complex. USA: Betascript Publishers.
6. Steven, G., & William, A.A. (2006). Listening to Speech: auditory perspectives. New Jersey: Lawrence Erlbaum Associates Inc.
7. Greenberg, S. (2004). Speech processing in the auditory system. USA: Springer-Verlag.

8. Enrique, A., & Lopez-Poveda (2010). The Neurophysiological Bases of Auditory Perception. USA: Springer-Verlag
9. Richard, A. (1991). Neurobiology of Hearing. USA: Raven Press.
10. Enrique, A., & Lopez-Poveda (2010). The Neurophysiological Bases of Auditory Perception. USA: Springer-Verlag
11. Adrian, R., & Alan. R. P. (2010). The Oxford Handbook of Auditory Science: The Auditory Brain. United Kingdom: Oxford University Press.
12. Moore, D., Alan, P., & Fuchs, P. (2010). Oxford handbook of auditory science the ear. United Kingdom: Oxford University Press.
13. Syka, J. (1996). Acoustical signal processing in the central auditory system.USA: Springer-Verlag.
14. Tremblay, K., & Robert F. B. (2013). Translational Perspectives in Auditory Neuroscience. San Diego: Plural Publications.

**Unit 3: Auditory cortex 18 Hrs**

1. Reinhard., K. (2005). The auditory cortex: a synthesis of human and animal research. New Jersy: Routledge Publishers.
2. Jasper, R., & Devon, I.R. (2009). Clinical neurophysiology. United Kingdom: Oxford University Press.
3. Greenberg, S., & William A. A. (2006). Listening to Speech: auditory perspectives. New Jersey: Lawrence Erlbaum Associates Inc.
4. Greenberg, S. (2004). Speech processing in the auditory system. USA: Springer-Verlag.
5. Enrique, A., & Lopez-Poveda (2010). The Neurophysiological Bases of Auditory Perception. USA: Springer-Verlag.
6. Douglas, B, W., Popper, A.N., & Fay, R.R. (1992). The Mammalian auditory pathway: neuroanatomy. New York: Springer-Verlag.
7. Jahn, A.F., & Santos-Sacchi J. (2001). Physiology of the ear. San Diego: Singular/Thomson Learning.
8. Enrique, A., & Lopez-Poveda (2010). The Neurophysiological Bases of Auditory Perception. USA: Springer-Verlag.
9. Aitkin, L. (1990). The auditory cortex: structural and functional bases of auditory perception. University of Michigen: Chapman and Hall.
10. Syka, J., & Merzenich, M.M. (2003). Plasticity and signal representation in the auditory system. USA: Springer Science.
11. Meddis, R.(2010). Computational Models of the Auditory System. USA: Springer-Verlag.
12. Syka, J. (1997). Acoustical signal processing in the central auditory system. USA: Springer Science.

**Unit 4: Anatomy & physiology of the efferent pathway and cranial nerves related to ear**


1. Lambert, M., Surhone, M.T., & Susan, F. M. (2010). Superior Olivary Complex. USA: Betascript Publishers.
2. Douglas, B.W., Arthur, N. P., & Fay, R.R. (1992).The Mammalian auditory pathway: neuroanatomy. New York: Springer-Verlag.
3. Douglas, B. W., Arthur, N. P., & Richard, R.F. (1992). The Mammalian auditory pathway: neurophysiology. New York: Springer-Verlag.
4. Anthony, F. J., & Santos-Sacchi, J. (2001). Physiology of the ear. San Diego: Singular/Thomson Learning.
5. Berlin, C.E. (1999). The efferent auditory system: basic science and clinical applications. USA: Singular Publishing Group.
6. Tony, L. S., Richard, H. N., & Musiek, F.E. (1997). Efferent auditory system: structure and function. USA: Singular Publishing Group.
7. Ryugo, D.K. (2010). Auditory and Vestibular Efferents. USA: Springer-Verlag.
8. Syka, J. (1997). Acoustical signal processing in the central auditory system. USA: Springer Science.

## Paper Code: AUD 2.3 b SC: Speech Production

### Objectives

1. After completing this course, the student shall be able to:
2. Describe the Physiology of Speech Production
3. Discuss the Acoustic Theories
4. Describe the Acoustic Characteristics of Various Speech Sounds
5. Know the Application of Acoustic Analysis and Speech Synthesis

### Unit 1: Introduction to the study of speech physiology 18 Hrs

1.1 The physiological aspects of speech production (respiration, laryngeal and articulatory subsystem)

1.2 Aerodynamics of speech
- Mechanics of airflow: Laminar, orifice and turbulent flow
- Generation of pressure in the respiratory system: Resting level, relaxation pressure curve
- Maintenance of airway pressure for speech: Elastic recoil, sub glottal pressure for speech.

1.3 Speech breathing

1.4 Measures of respiratory analysis and instrumentation:
- Air volume
- Air flow
- Air pressure measurements including intraoral and sub glottal pressure
- Instruments for respiratory analysis

### Unit 2: Theories and instrumentation in speech production 18 Hrs

2.1 Acoustic theory of speech production:

- Source, types and its characteristics
- Filter / transfer function and its characteristics
- Output speech and its characteristics
- Cavity volume and resonance relationship
- Critical evaluation of acoustic theory of speech production

2.2 Fundamental aspects of speech acoustics
- Acoustic wave
- Analog and digital signal
- Digitization
- Analog-to-digital conversion
- Sampling

- Quantization
- Bandwidth
- Frequency resolution
- Window
- Block duration
- Pre-emphasis
- Filtering
- Block shift

2.3 Acoustic analysis of speech
- Digital signal processing [waveform analysis, fast fourier transformation (FFT) and linear prediction correlation (LPC), pitch extraction, auto correlation, digital spectrogram, inverse filtering, long term average spectrum (LTAS), cepstrum]

2.4 Data acquisition systems- acoustic analysis softwares
- Format analysis
- Formant tracking
- F0 and intensity analysis
- Computerized Speech Lab (CSL)
- PRAAT

**Unit 3: Acoustic characteristics of speech sounds and spectrography 18 Hrs**

3.1 Spectrogram
- Spectrograms of vowels and consonants
- Identifying place of articulation, manner of articulation, voicing and aspiration
- Identification of vowels, syllables, words, word boundaries and sentences

3.2 Acoustic characteristics of vowels and diphthongs
- Vowel classification
- Vowel formant pattern
- Vowel short-term spectrum
- Vowel duration
- Vowel fundamental frequency
- Formant bandwidth and amplitude on glide and off glide of formants

3.3 Acoustic characteristics of plosives
- Vocal tract configuration
- Five distinct characteristics of Plosives
- Closure duration
- Release burst
- Release burst spectrum
- Release burst amplitude
- Friction and aspiration
- Voice onset time
- Formant transitions
- Voicing characteristics

3.4 Acoustic characteristics of nasal consonants
- Vowel tract configuration
- Formant frequencies
- Nasal murmur
- Formant damping
- Bandwidth
- Formant transitions
- Antiformants

3.5 Acoustic characteristics of fricatives
- Vocal tract configuration
- Classification of fricatives
- Acoustic characteristics of stridents and non-stridents

3.6 Acoustic characteristics of other consonants
- Affricates: Vocal tract configuration, acoustic differences between affricates and plosives
- Glides: Vocal tract configuration, formants, and transitions
- Liquids: Vocal tract configuration, formants, anti formants and transitions.

**Unit 4: Application of acoustic analysis and speech synthesis 18 Hrs**

4.1 Applications of acoustic analysis in speech disorders: speech of persons with hearing impairment, stuttering, dysarthria, cleft lip and palate

4.4 Speech Synthesis:
- Types: Articulatory synthesis, parametric synthesis and analysis by synthesis
- Applications of speech synthesis

**Practicum:**

- Measurement of aerodynamic parameters using spirometer and aeroview
- Practical on fft, lpc, cepstrum and inverse filtering
- Acoustic analysis of vowels, diphthongs, plosives, nasals, fricatives, affricates and other speech sounds using spectrograms on PRAAT
- Vowel synthesis using parametric and analysis by synthesis
- Demonstration of articulatory synthesis

**References:**

**Unit 1: Introduction to the study of speech physiology**


1. Barlow, S. M. (1999). *Hand Book of Clinical Speech Physiology.* San Diego, Singular Publishing Group.
2. Borden, G. J., & Harris, K. S. (2003). *Speech Science Primer.* 4th Edition, Philadelphia. Lippincott, William & Wilkins.
3. Daniloff. R. S., Gordon & Lawrence, (1980). *The Physiology of Speech & Hearing: An Introduction.* New Jersey, Prentice-Hall Inc.
4. Hixon, T. J. Weismer, G. & Hoit, J. D. (2008). *Preclinical Speech Sciences; Anatomy Physiology Acoustics Perception.* San Diego, Plural Publishing.
5. Hixon, T. J., Weismer, G., & Hoit, J. D. (2014). *Preclinical Speech Sciences; Anatomy Physiology Acoustics Perception.* San Diego, Plural Publishing.
6. Mac Neilage, P F. (1983). *The Production of Speech.* NY, Springer – Verlag.
7. Raphael, L. J. (2007). *Speech Science Primer*. Philadelphia, Lippincott Williams & Wilkins.
8. Seikal, J. A., & King, D. W. (2005). *Anatomy & Physiology for Speech, Language and Hearing.* 4th Edition, NY, Thompson – Delmar Learning.


**Unit 2: Theories and instrumentation in speech production**


1. Barry, W. J., & Van Dommelen, W. A. (2005). *Integration of Phonetic Knowledge in Speech Technology*. New York, Springer.
2. Charles, E. (1999). *Introduction to Sound: Acoustics for the Hearing & Speech Sciences*. New York, Delmar Cengage Learning.
3. Daniloff. R. G. (1985). *Speech Sciences; Recent Advances.* London, Taylor & Francis Ltd.
4. Ferrand, C. T. (2007). *Speech Science – An Integrated Approach to Theory and Practice.* 2nd Edition, Boston, Allyn & Bacon.
5. Ferrard, C. T. (2001). *Speech Science – An Integrated Approach to Theory and Practice.* 1st Edition, Boston, Allyn & Bacon.
6. Fucci, D. J., & Lass, N. J. (1999). *Fundamental of Speech Sciences.* Boston, Allyn & Bacon.
7. Fry, D. D. (1979). *The Physics of Speech.* New Delhi. Cambridge University Press.
8. Hewlett, N., & Beck, J. M. (2006). *An Introduction to the Science of Phonetics.* New Jersey, Lawrence Erlbaum Associates Publishers.
9. Kent, R. D., & Read, C. (2002). *The Acoustic Analysis of Speech.* New York, Delmar Learning.
10. Ladefogd, P. (2001). *An Introduction to the Sounds of Languages; Vowels and* Consonants. Oxford, Black Well.
11. Mc Leod, S., & Singh, S. (2009). Speech Sounds; A Pictorial Guide to Typical and Atypical Speech. San Diego, Plural Publishing.

12. Raphael, L. J. (2007). Speech Science Primer. Philadelphia, Lippincott Williams & Wilkins.
13. Saito, S. (1992). Speech Science & Technology. Ohmsha, Tokyo.
14. Ryalls, J., & Behrans, S. (2000). Introduction *to Speech Sciences - From Basic Theories to Clinical Applications*. Boston, Allyn & Bacon.

**Unit 3: Acoustic characteristics of speech sounds and spectrography**

1. Baken, R. J., & Daniloff, R. G. (1991). *Readings in Clinical Spectrography*. San Diego, Singular Publishing Group.
2. Ball, M. J., & Lowry, O. M. (2001). *Methods in Clinical Phonetics*. London, Whurr Publishers.
3. Barr, R. G. (2000). *Crying as a Sign, a Symptom and a Signal: Clinical, Emotional and Developmental Aspects of Infant and Toddler Crying.* Cambridge, Cambridge University.
4. Edwards, A. T. (2003). *Applied Phonetics*; *The Sounds Of American English.* New York, Thomson Delmar Learning.
5. Edwards, A. T. (1992). *Applied Phonetics; The Sounds of American English*. New York; San Diego, Singular Publishing Group.
6. Hewlett, N., & Beck, J. M. (2006). *An Introduction to the Science of Phonetics.* New Jersey, Lawrence Erlbaum Associates Publishers.
7. Kent, R. D. (1997). *Speech Sciences.* London, San Diego, Singular Publishing Group.
8. Kent, R. D., & Read, C. (2002). *The Acoustic Analysis of Speech.* New York, Delmar Learning.
9. Ladefoged, P. (1996). *Elements of Acoustic Phonetics.* 2nd Edition, Chicago, University of Chicago.
10. Ladefogd, P. (2001). *An Introduction to the Sounds of Languages; Vowels and Consonants*. Oxford, Black Well.
11. Murry, T., & Murry, J. (1980). *Infant Communication: Cry and Early Speech.* San Diego, College – Hill Press.
12. Pickett, J. M. (1980). *Sounds of Speech Communication. A Primer of Acoustic Phonetics and Speech Perception.* Boston, Allyn & Bacon.
13. Pickett, J. M. (1999). *The Acoustics of Speech Communication: Fundamentals, Speech Perception Theory & Technology.* Boston, Allyn & Bacon.
14. Raphael, L. J. (2007). *Speech Science Primer*. Philadelphia, Lippincott Williams & Wilkins.
15. Rosner, B. S. & Pickering, J. B. (1994). *Vowel Perception & Production*. London, Oxford University Press.
16. Savithri, S. R. (2000). Acoustic Analysis of Laughter, *Journal of Acoustic Society of India. 28*(1), 233-238.
17. Stevens, K. N. (2000). *Acoustic Phonetics.* Massachusetts, MIT Press.

**Unit 4: Application of acoustic analysis and speech synthesis**


1. Baken, R. J., & Daniloff, R. G. (1991). *Readings in Clinical Spectrography*. San Diego, Singular Publishing Group.
2. Barr, R. G. (2000). *Crying as a Sign, A Symptom and a Signal: Clinical, Emotional and Developmental Aspects of Infant and Toddler Crying.* Cambridge, Cambridge University.
3. Boeffard, O., & D'Alessandro, C. (2009). Speech Synthesis. In Mariani, J. (Eds.) *Spoken Language Processing* (Pp. 99-154). Wiley Publishers, London, UK.
4. Borden, G. J., & Harris, K. S. (2003). *Speech Science Primer.* 4th Edition, Philadelphia, Lippincott, William & Wilkins.
5. Deng, L., & O'Shaughnessy, D. (2003). *Speech Processing: A Dynamic and Otimization-Oriented Approach*. New York, Marcel Dekker Inc.
6. Fant, G. (2004). *Speech Acoustics and Phonetics*. Dordrecht, Kluwer Academic Publishers.
7. Harrington, J., & Cassidy, S. (1999). *Techniques in Speech Acoustics*. Dordrecht, Kluwer Academic Publishers.
8. Hollien, H. (2002). *Forensic Voice Identification.* NY, Academic Press Inc.
9. Keller, E., Bailly, G., Monaghan, A., Terken, J., & Huckvale, M. (2002). *Improvements in Speech Synthesis*. West Sussex, England, John Wiley & Sons.
10. Mc Leod, S. & Singh, S. (2009). *Speech Sounds; A Pictorial Guide to Typical and Atypical Speech.* San Diego, Plural Publishing.
11. Murry, T. & Murry, J. (1980). *Infant Communication: Cry and Early Speech.* San Diego, College – Hill Press.
12. Singh. S. & Singh. K. (2006). *Phonetics: Principles and Practices.* 3rd Edition, San Deigo, Plural Publishing.
13. Tatham, M., & Morton, K. (2005). *Developments in Speech Synthesis*. West Sussex, England, John Wiley & Sons.
14. Titze, I. R. (1994). *Principles of Voice Production.* New Jersy, Prentice – Hall Inc.


**Journal s to be referred:**

1. Journal of Acoustical Society of America
2. Journal of Logopedics Phoniatrics & Vocology,
3. Folia Phoniatrica
4. Phonetica
5. Phonology
6. Journal of Phonetics
7. Journal of Speech Production
8. Journal of Speech, Language, and Hearing Research
9. Journal of All India Institute of Speech and Hearing
10. Journal of Indian Speech and Hearing Association
11. Speech Communication
12. Speech Language and Hearing

## Paper Code: AUD 2.4 a - SC: Age related changes in Audio-Vestibular System

**Objectives:**

**After successful completion of this course, the student should be able to**

1. Explain the age-related changes in peripheral, central auditory and vestibular systems.
2. Modify tests and interpret their outcomes taking into account an individual's age

### Unit 1: Anatomical and physiological changes in the audio-vestibular system from embryonic stages onwards. 18 Hrs

1.1 Conductive mechanism
- External ear (pinna, external auditory meatus and tympanic membrane)
- Middle ear

1.2 Cochlea
- Hair cells
- Stria vascularis
- Basilar membrane properties
- Transduction properties
- Other structures

1.3 Peripheral vestibular system
- Semi-circular canals
- Otolith organs (Utricle & Saccule

1.4 Age at which maturation is attained and age at which decline commences for:
- Conductive mechanism
- Cochlea
- Peripheral vestibular system

### Unit 2: Anatomical and physiological changes in audio-vestibular nervous system from embryonic stages onwards. 18 Hrs

2.1 Auditory nervous system
- Auditory nerve
- Other structures suchas cochlear nucleus, SOC, lateral leminiscus, inferior colliculus, auditory thalamus and auditory cortex

2.2 Vestibular nervous system
- Vestibular nerve
- Vestibular nucleus
- Other structures: cerebellum, vestibular cortex
- VOR and VSR reflex pathways

2.3 Neurotransmitter properties and changes in various neuro-transmitters duet o ageing

2.4 Age at which maturation is attained and age at which decline commences for:
- Auditory nervous system
- Vestibular nervous system

**Unit 3: Effect of age on behavioural auditory and vestibular responses 18 Hrs**

3.1 Tests of auditory function
- Psychophysical measures
  - Absolute thresholds
  - Difference limens for intensity, frequency and duration
  - Loudness
  - Pitch
- Central auditory processes
  - Temporal processing
  - Binaural integration
  - Binaural interaction
  - Localization/Lateralization
  - Binaural separation
  - Auditory closure

3.2 Tests for vestibular function
- Romberg test
- Fukuda stepping test
- Tandem gait test
- Doam and foam test
- Past pointing test (finger-to-noise test)
- Subjective visual vertical

**Unit 4: Effect of age on physiological responses of auditory and vestibular systems 18 Hrs**

4.1 Physiological assessment of auditory system
- Tympanometry and reflexometry
- Otoacoustic emissions (TEOAE, DPOAE and fine structure)

4.2 Electrophysiological assessment of auditory system
- Auditory brainstem responses to speech and non-speech stimuli
- Auditory middle latency responses
- Auditory late latency responses to speech and n on-speech stimuli
- Other event related potentials – MMN, $P_{300}$.

4.3 Vestibular electrophysiological changes
- Vestibular evoked myogenic potentials
  - Cervical VEMP
  - Ocular VEMP
- Oculomotor evaluation
  - Gaze test

  - Optokinetic test
  - Smooth pursuit test
  - Saccade test
- Positional and positioning test
- Video head impulse test
- Bithermal caloric test
- Computerized dynamic posturography
- Rotary chair test

**PRACTICUM:**

1. Collect and watch videos and slides showing embryological developmental, maturation and ageing associated changes in the audio-vestibular system; explain the changes observed.
2. Make separate test protocols for auditory and vestibular system assessment for infants, toddlers, and older adults.

**References:**

**Unit-1: Anatomical and physiological changes in the audio-vestibular system from embryonic stages onwards.**


1. Armstrong, D., Stoney, P., Hawke, M., & Farkashidy, J. (1992). Presbycusis: correlations of clinical audiology with morphological changes in the cochlea and the ventral cochlear nucleus. *Journal of Otolaryngology*, 21(5), 343-349.
2. Goldberg, J., Buettner-Ennever, J. A., & Fukushima, K. (2007). The vestibular system. Oxford: Oxford University Press.
3. Gordon-Salant, S., Frisina, R. D., Fay, R. R., & Popper, A. (2010). The Aging Auditory System (Springer Handbook of Auditory Research). New York: Springer-Verlag.
4. Highstein, S., Fay, R., & Popper, A. (2003). The vestibular system. New York: Springer Publishers.
5. Hughes, G. B., & Pensak, M. L. (2007). Clinical otology. New York: Theime Medical Publishers.
6. Merchant, S. N., Velazquez-Villasenor, L., Tsuji, K., Glynn, R. J., Wall, C3., & Rauch, S. D. (2000). Temporal bone studies of the human peripheral vestibular system. Normative vestibular hair cell data, *Annals of Otology Rhinology and Laryngology Supplement* 181, 3-13.
7. Nelson, E. G., & Hinojosa, R. (2003). Presbycusis: A human temporal bone study of individuals with flat audiometric patterns of hearing loss using a new method to quantify stria vascularis volume. *The Laryngoscope*, 113(10), 1672-1686.
8. Nelson, E. G., & Hinojosa, R. (2006). Presbycusis: A human temporal bone study of individuals with downward sloping audiometric patterns of hearing loss and review of the literature. *The Laryngoscope*. 116 (9 Pt 3 Supplement 112), 1-12.

9. Ohlemiller, K. K., & Gagnon, P. M. (2004). Apical-to-basal gradients in age-related cochlear degeneration and their relationship to "primary" loss of cochlear neurons. *Journal of Comparative Neurology*, 479(1), 103-116.
10. Poeppel, D., Overath, T., & Popper, A. N. (2012). The Human Auditory Cortex. New York: Springer Publishers.
11. Romand, R., & Varela-Niet, I. (2003). Development of Auditory and Vestibular Systems-3. New York: Academic Press.
12. Rubel, E. W., & Fay, R. R. (2012). The development of the auditory system. New York: Springer Publishers.
13. Ryugo, D. K., Fay, R. R., & Popper, A. N. (2010). Auditory and vestibular efferents. New York: Springer Publishers.
14. Sandara, G., Frisinia, R., Fay, R., & Popper, A. (2010). The aging auditory system. New York: Springer Publishers.
15. Terao, K., Cureoglu, S., Schachern, P. A., Morita, N., Nomiya, S., Deroee, A. F., Doi, K., Mori, K., Murata, K., & Paparella, M. M. (2011). Cochlear changes in presbycusis with tinnitus. *American Journal of Otolaryngology*, 32(3), 215-220.
16. Velazquez-Villasenor, L., Merchant, S. N., Tsuji, K., Glynn, R. J., Wall C3., & Rauch, S. D. (2000). Temporal bone studies of the human peripheral vestibular system. Normative Scarpa's ganglion cell data. *Annals of Otology Rhinology and Laryngology Supplement* 181, 14-19.
17. Weinstein, B. E. (2000). Geriatric Audiology. New York: Theime Medical Publishers.
18. Werner, L., Fay, R. R., & Popper, A. N. (2012). Human Auditory Development. New York: Springer Publishers.

**Unit-2: Anatomical and physiological changes in audio-vestibular nervous system from embryonic stages onwards.**


1. Chen, B., Zhong, Y., Peng, W., Sun, Y., & Kong, W. J. (2010). Age-related changes in the central auditory system: comparison of D-galactose-induced aging rats and naturally aging rats. *Brain Research*, 1344, 43-53.
2. Frisina, R. D., & Walton, J. P. (2006). Age-related structural and functional changes in the cochlear nucleus. *Hearing Research*, 16(217), 216-23.
3. Goldberg, J. Buettner-Ennever, J. A., Fukushima, K. (2007). The Vestibular System. Oxford University Press.
4. Gordon-Salant, S., Frisina, R. D., Fay, R. R., & Popper, A. (2010). The Aging Auditory System (Springer Handbook of Auditory Research). New York: Springer-Verlag.
5. Hinojosa, R., & Nelson, E. G. (2011). Cochlear nucleus neuron analysis in individuals with presbycusis. *The Laryngoscope*, 121(12), 2641-2648.
6. Hughes, G. B., & Pensak, M. L. (2007). Clinical otology. Theime Publishers.
7. Makary, C. A., Shin. J., Kujawa, S. G., Liberman, M. C., & Merchant, S. N. (2011). Age-related primary cochlear neuronal degeneration in human temporal bones. *Journal of the Association for Research in Otolaryngology,* 12(6), 711-717.
8. Ohlemiller, K. K., & Gagnon, P. M. (2004). Apical-to-basal gradients in age-related cochlear degeneration and their relationship to "primary" loss of cochlear neurons. *Journal of Comparative Neurology*, 479(1), 103-16.
9. Poeppel, D., Overath, T., & Popper, A. N. (2012). The human auditory cortex. New York: Springer Publishers.
10. Romand, R., & Varela-Niet, I. (2003). Development of auditory and vestibular systems-3. Academic Press.
11. Rubel, E. W., & Fay, R. R. (2012). The development of the auditory system. New York: Springer Publishers.
12. Ryugo, D. K., Fay, R. R., & Popper, A. N. (2010). Auditory and vestibular efferents. New York: Springer Publishers.
13. Sandara, G., Frisinia, R., Fay, R., & Popper, A. (2010). The aging auditory system. New York: Springer Publishers.
14. Shim, H. J., Lee, L. H., Huh, Y., Lee, S. Y., & Yeo, S. G. (2012). Age-related changes in the expression of NMDA, serotonin, and GAD in the central auditory system of the rat. *Acta Otolaryngologica,* 132(1), 44-50.
15. Weinstein, B. A. (2000). Geriatric Audiology. Theime Medical Publishers.
16. Werner, L., Fay, R. R., & Popper, A. N. (2012). Human Auditory Development. New York: Springer Publishers.

**Unit-3: Effect of age on behavioural auditory and vestibular responses**


1. Amos, N. E., & Humes, L. E. (2007). Contribution of high frequencies to speech recognition in quiet and noise in listeners with varying degrees of high-frequency sensori-neural hearing loss. *Journal of Speech Language and Hearing Research*, 50, 819-834.
2. Burk, M. H., & Humes, L. E. (2008). Effects of long-term training on aided speech-recognition performance in noise in older adults. *Journal of Speech Language and Hearing Research*, 51, 759-771.
3. Burk, M. H., Humes, L. E., Amos, N. E., & Strauser, L. E. (2006). Effect of training on word-recognition performance in noise for young normal-hearing and older hearing-impaired listeners. *Ear and Hearing*, 27, 263-278.
4. Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) (1988). Speech understanding and aging. *Journal of the Acoustical Society of America*, 83, 859-895.
5. Cooper, J. C. Jr., & Gates, G. A. (1991). Hearing in the elderly-the Framingham cohort, 1983–1985: Part II. Prevalence of central auditory processing disorders. *Ear and Hearing*, 12, 304-311.
6. Divenyi, P. L., & Haupt, K. M. (1997). Audiological correlates of speech understanding in elderly listeners with mild-to-moderate hearing loss. II. Correlational analysis. *Ear and Hearing*, 18, 100-113.
7. Divenyi, P. L., & Haupt, K. M. (1997). Audiological correlates of speech understanding in elderly listeners with mild-to-moderate hearing loss. III. Factor representation. *Ear and Hearing*, 18, 189-201.
8. Dubno, J. R., Horwitz, A. R., & Ahlstrom, J. B. (2002). Benefit of modulated maskers for speech recognition by younger and older adults with normal hearing. *Journal of the Acoustical Society of America*, 111, 2897-2907.
9. Dubno, J. R., Horwitz, A. R., & Ahlstrom, J. B. (2003). Recovery from prior stimulation: masking of speech by interrupted noise for younger and older adults with normal hearing. *Journal of the Acoustical Society of America*, 113, 2084-2094.
10. George, E. L. J., Zekveld, A. A., Kramer, S. E., Goverts, S. T., Festen, J. M., & Houtgast, T. (2007). Auditory and nonauditory factors affecting speech reception in noise by older listeners. *Journal of the Acoustical Society of America*, 121, 2362-2375.
11. Gerber, S. E. (1996). The handbook of pediatric audiology. Washington, DC: Galludet University Press.
12. Gordon-Salant, S., Frisina, R. D., Fay, R. R., & Popper, A. (2010). The Aging Auditory System (Springer Handbook of Auditory Research). New York: Springer-Verlag
13. Madell, J. R., & Flexer, C. A. (2004). Pediatric audiology: diagnosis, technology, and management. New York: Thieme Medical Publishers.
14. Madell, J., & Flexer, C. (2006). Pediatric audiology casebook. New York: Thieme Medical Publishers.
15. McCormic, B. (1995). The medical practitioner's guide to paediatric audiology. New York: Cambridge University Press.
16. McCormick, B. (2004). Paediatirc audiology (0-5 years). London: Whurr Publishers

17. Musiek, F. E., & Chermak, G. D. (2014). Handbook of central auditory processing disorders. Volume I: Auditory neuroscience and diagnosis. 2nd Ed. San Diego, CA: Plural Publishing Inc.
18. Newton, V. E. (2009). Paediatric audiological medicine. London: Whurr Publishers.
19. Northern, J. L. & Downs, M. P. (2007). Hearing in Children. Philadelphia Lippinkot: Williams and Willkins.

**Unit-4: Effect of age on physiological responses of auditory and vestibular systems**

1. Anderson, S., Parbery-Clark, A., Yi, H. G., & Kraus, N. (2011). A neural basis of speech-in-noise perception in older adults. *Ear and Hearing*, 32(6), 750-757.
2. Burkard, R. F., Eggermont, J. J., & Don, M. (2006). Auditory evoked potentials: basic principles and *clinical* application. Lippinkot: Williams and Wilkins.
3. Gerber, S. E. (1996). The Handbook of pediatric audiology. Washington, DC: Galludet University Press.
4. Hall, J. W. (2010). New handbook for auditory evoked responses. Boson, MA: Allyn and Bacon
5. Harris, K. C., Mills, J. H., He, N. J., & Dubno, J. R. (2008). Age-related differences in sensitivity to small changes in frequency assessed with cortical evoked potentials. *Hearing Research*, 243(1-2), 47-56.
6. Katz, Burkard, J. R. F., & Medwetsky, L. (2010). Handbook of clinical audiology. Lippinkot: Williams and Wilkins.
7. Konrad-Martin, D., Dille, M. F., McMillan, G., Griest, S., McDermott, D., Fausti, S. A., & Austin, D. F. (2012). Age related changes in the auditory brainstem response. *Journal of the American Academy of Audiology*, 23(1), 18-35.
8. Musiek, F. E., & Chermak, G. D. (2014). Handbook of central auditory processing disorders. Volume I: Auditory neuroscience and diagnosis. 2nd Ed. San Diego, CA: Plural Publishing Inc.
9. Northern, J. L., & Downs, M. P. (2007). Hearing in children. Philadelphia: Lippinkot: Williams and Willkins.
10. Swartz, K. P., Walton, J. P., Hantz, E. C., Goldhammer, E., Crummer, G. C., & Frisina, R. D. (1994). $P_3$ event-related potentials and performance of young and old subjects for music perception tasks. International *Journal of Neuroscience*, 78(3-4), 223-239.
11. Tremblay, K. L., Piskosz, M., & Souza, P. (2003). Effects of age and age-related hearing loss on the neural representation of speech cues. *Clinical Neurophysiology*, 114(7), 1332-1343.

## Paper Code: AUD 2.5 b - SC: *Clinical Behaviour analysis*

**Objectives**

After successful completion of the course student will be:

- Prepared in the specific area of clinical behavior analysis, therapy or change programs for affected individuals with communication disorders.
- Trained in practical skills and competencies required for mastering basics of clinical behavior analysis in their practice for identification and management of persons with communication disorders
- Sensitized on the ethical aspects of clinical behavior analysis when dealing with individuals or their families with communication disorders.
- Able to integrate clinical behavior analysis and counselling based aspects in the field of research in communication disorders.

**Unit 1: Introduction 18 Hrs**

1.1 Learning: Meaning and Types
1.2 Behavioral Perspectives: History to current trends in Behavior Medicine
1.3 Behavioral Theories. Pavlov: Skinner and Watson
1.4 Concept of Behavior Therapy and Behavior Modification
1.5 Behavioral Assessment: Meaning & Characteristics - Behavioral Perspective
1.6 Recent Variations: Applied Behavior Analysis and Dialectical Behavioral Counseling – ABC Model

**Unit 2: Behavior assessment 18 Hrs**

2.1 Behavior Assessment Scales: Western and Indian-AAMD Adaptive Behavior Scale, ***PBCL,*** BASIC-MR, ACPC-DD, MDPS, etc
2.2 Skills, Steps and Strategies: Procedure of Behavior Assessment & Management: Skill Training and Problem Behavior Remediation
2.3 Shaping, Chaining, Prompting, Fading, Modeling, Contingency Contracting, Reward Training, Token Economy, Activity Scheduling, Systematic Desensitization, Flooding, Aversion Techniques
2.4 Self Management Techniques: Correspondence Training

**Unit 3: Behavior change techniques 18 Hrs**

3.1 Behavior Change Techniques: Shaping, Chaining, Prompting, Compliance training, Stress Management/ Relaxation Techniques: JPMR, Yoga – Habit Reversal Techniques – Paradoxical Intention – Negative Practice
3.2 Operant Procedures and Techniques: Counter-Conditioning, Desensitization, Aversive Conditioning Procedures,
3.3 Self-control Procedures and Cognitive Procedures
3.4 Time Out, Over-correction

**Unit 4: Allied behavioral procedures 18 Hrs**

4.1 Biofeedback: EEG, EMG, GSR, EKG and Thermal – Polygraph;
4.2 Cognitive Behavior Techniques: Beck and Ellis – Reality Therapy and Transactional Techniques

**Practicum:**

1. Interviewing of parents for skill and problem behavior mapping.
2. Setting behavioural objectives for program planning.

**References:**

**Unit 1: Introduction**


1. Feldman, M.P., & Broadhurst, A. (1976).*Theoretical and experimental bases of the behavior therapy*. London: Wiley.
2. Housten, R.V., & Axelrod, S. (1993). *Behavior analysis and treatment*. New York: Springer.
3. Kearney, A.J. (2007). *Understanding Applied Behavior Analysis: An Introduction.* London: Jessica Kingsley.
4. Malott, R., Tillema, M., & Glenn, S. (1978). *Behavior analysis and behavior modification: an introduction*. Kalamazoo, MI: Behaviordelia.
5. Hersen, M. (2005). *Encyclopedia of behavior modification and Cognitive behavior therapy.* California: Sage Publications.
6. Bellack, S. (1985). *International handbook of behavior modification and therapy.* New York: Plenum Press.
7. Venkatesan, S. (2004). *Children with Developmental Disabilities: a training guide for parents, teachers and caregivers.* New Delhi: Sage.
8. Peshawaria, R., & Venkatesan, S. (1992). *Behavior approach in teaching mentally retarded children: a manual for teachers.* Secunderabad: NIMH.


**Unit 2: Behavior assessment**


1. Ramnero, J., & Törneke, N. (2008). *ABCs of human behavior: Behavioral principles for the practicing clinician.* Oakland, CA: New Harbinger & Reno, NV: Context Press.
2. Miltenberger, R.G., (2008). *Behavior modification: Principles and procedures (4th Ed.).* Pacific Grove, CA: Thomson/Wadsworth.
3. Woods, D. W., & Kanter, J. W. (Eds.). (2007). *Understanding behavior disorders: A contemporary behavioral perspective*. Reno, NV: Context Press.
4. Cooper, J.O., Heron, T.E. & Heward, W.L. (2007). *Applied Behavior Analysis (2nd Edition)*. Prentice Hall.
5. Baum, W. M. (2004). *Understanding Behaviorism: Behavior, Culture, and Evolution (2nd edition)*. Wiley-Blackwell.

6. Pierce, W.D. & Cheney, C.D. (2003). *Behavior Analysis and Learning, 3rd edition.* Lawrence Erlbaum.

**Unit 3: Behavior change techniques**

1. Baldwin, J.D., & Baldwin, J.I. (2000). *Behavior Principles in Everyday Life (4th Edition)*. Prentice Hall.
2. Dougher, M. J. (Ed.). (2009). *Clinical Behavior Analysis.* Reno, NV: Context Press.
3. Chiesa, M. (1994). *Radical Behaviorism: The philosophy and science*. Cambridge Center.
4. Leigland, S. (1992). *Radical behaviorism: Willard Day on psychology and philosophy*. Reno, NV: Context Press.
5. Catania, C. (1992). *Learning*. Prentice Hall.
6. Hayes, S. C. (Ed.). (1989/2004). *Rule Governed behavior: Cognition, contingencies, and instructional control.* New York: Plenum / reprinted in 2004 by Context Press.
7. Skinner, B.F. (1965). *Science and Human Behavior*. Free Press.

**Unit 4: Allied behavioral procedures**

1. Culbert, T.P. (1999). *Biofeedback with Children and Adolescents. In Innovative Psychotherapy Techniques in Child and Adolescent Therapy.* , Edited by C. Schaefer. New York: John Wiley.
2. Di Franco, J.T. (2000). *Biofeedback. In Childbirth Education: Practice, Research and Theory,* Edited by F. H. Nichols and S. S. Humenick. Philadelphia: W. B. Saunders.
3. Schwartz, M.S. (1987). *Biofeedback: A Practitioner's Guide.* New York: Guilford.
4. Spencer, J.W., & Jacobs, J.J. (1999). *Complementary/Alternative Medicine: An Evidence-Based Approach.* Baltimore: Mosby.
5. Stoyva, J.M., & Thomas H.B. (1993). *Biofeedback Methods in the Treatment of Anxiety and Stress Disorders.* In Principles and Practice of Stress Management. Edited by P. M. Lehrer and R. L. Woolfolk. New York: Guilford Press.

## Paper Code: AUD 2.6 - HC: Clinical Practicum II

## SEMESTER III

## Paper Code: AUD 3.1 - HC: Implantable Devices for Individuals with Hearing Impairment

**Objectives:**

At the end of the course, the student shall be able to:

- Identify, describe the types of implantable hearing devices and describe the purpose(s) of each component used in implantable hearing devices.
- Select candidates for implantable hearing devices.
- Assess and counsel the benefit from implantable hearing devices.
- Suggest schemes / loans to obtain implantable hearing devices.

**Unit 1: Partial and total implantable hearing aids 10 Hrs**

1.1 Bone-conduction implantable devices
- Candidacy
- Components
- Overview to surgery
- Types bone conduction implantable devices (Percutaneous & Transcutaneous)

1.2 Middle ear implants
- Candidacy
- Components
- Overview to surgery

1.3 Types of middle ear implants
- Partial implantable and Totally implantable devices
- Electro-mechanical and piezo-electric

1.4 Evaluation of bone-conduction implantable devices & middle ear implants
- Pre-operative evaluation
- Fitting
- Assessment of benefits

1.5 Counselling regarding partial and total implantable hearing aids
- Care and maintenance
- Trouble shooting of the device

**Unit 2: Cochlear implants 14 Hrs**

2.1 Introduction to cochlear implants
- Overview to development of cochlear implants
- Overview to biological safety
- Surgical procedures in brief
- Complications and immunization
- International and national regulations for implantable devices

2.2 Cochlear implant features
- Types: Bilateral implants, hybrid implants, bimodal implants
- Components
- Coding strategies within and across companies
- Device failure (hard and soft)

2.3 Candidacy
- Non-audiological criteria
- Audiological criteria
- Role of team members in candidacy selection
- Expansion of cochlear implant candidacy

2.4 Pre-operative evaluation for children and adults
- Behavioural: Speech and non-speech
- Objective: OAE, Immittance evaluation, Auditory evoked potentials including eABR

2.5 Counseling (pre-operative)
- Realistic expectations; Predictors of benefit from cochlear implants including genetic predictors
- Role of team
- Loan, insurance
- Pre-operative counseling; Procedure for obtaining consent
- Contraindication for cochlear implants

**Unit 3:Mapping / Programming 18 Hrs**

3.1 Overview to Mapping / Programming
- Pre-requisites for mapping: pre-implant radiological report, Post-implant radiological report; Discharge report of surgeon; Non-physiological objective measures (electrode impedance, compliance, electrode voltage)
- Map parameters: Pulse width, stimulation rate, maxima, frequency allocation and re-distribution ,
- Mapping of those with malformations of the cochlea
- Effect of map parameters on loudness and pitch perception

3.2 Mapping procedure
- Mapping using behavioural measures
- Mapping using objective measures (ECAP & ESRT)

3.3 Evaluations
- Assessment of benefit: Non-speech and speech tests
- Electrophysiological measures (EABR and other evoked potentials)
- Optimization of: Hearing aid in the contralateral ear for bimodal implants; Bilateral cochlear implants; Electroacoustic stimulation

3.4 Overview to psychophysics of perception through cochlear implants: Intensity discrimination, loudness perception, loudness growth, loudness adaptation, loudness summation, pitch discrimination, gap detection, frequency resolution, temporal integration, masking, binaural phenomenon.

3.5 Counseling (post-operative)
- Care and maintenance, trouble shooting
- Counseling regarding outcome measures and follow-up
- Counseling regarding importance of habilitation
- Warranty.

**Unit 4: Brainstem implant, midbrain implants**

4.1 Candidacy for Brainstem implant, Midbrain implants
- Non-audiological criteria
- Audiological criteria
- Surgical procedures in brief

4.2 Pre-operative evaluation for children and adults; ABI/MBI team

4.3 Components, types, features; Mapping procedure of Brainstem implants, Midbrain implants

4.4 Post implant evaluation and benefits from Brainstem implant, Midbrain implants

4.5 Future needs in implantable devices (implantable hearing aids, cochlear implants, brainstem implant, midbrain implants)

**Practicum:**

1. Observation of mapping and recording NRT in cochlear implantees and write an analytic report.
2. From 10 case files, make recommendations for further testing to decide candidacy for implantable devices.
3. Compile information from 10 case files of individuals with hearing impairment (5 children & 5 adults) and make recommendations whether implantable devices are to be recommended or not.
4. Simulate map parameters to increase ‘C’ / ‘M’ levels.
5. Compile map parameters of implantable devices available in India.

**References:**

**Unit 1: Partial and total implantable hearing aids.**


1. Boheim, K. (2010). Active middle ear implants. Basel: Karger.
2. Dillon, H. (2012). Hearing aids. II Ed. Chap 17: CROS, Bone conducted and implanted hearing aids. New York: Thieme Medical Publishers.
3. Hathiram Bachi, T., & Khattar Vicky S. (2013). Atlas of operative otorhinolaryngology and head neck Surgery (Vol. 1). New Delhi: Jaypee Brother Medical Publishers.
4. Kompis, M., & Caversaccio, M.D. (2011). Implantable Bone Conduction Hearing Aids. Switzerland: Karger Publishers.
5. Dutt, S. (2002). The Birmingham Bone Anchored Hearing Aid Programme-Some Audiological and Quality of life outcomes. Den Haag: Print Partners Ipskamp.
6. Kompis, M., & Caversaccio, M.D. (Eds.). (2011). Implantable Bone Conduction Hearing Aids. (New Delhi) Switzerland: Karger.
7. Manenkar, G. (2014). Implantable hearing devices other than cochlear implants. New Delhi: Springer-Verlag.
8. Ruckenstein, M. J. (2012). Cochlear implants and other implantable devices. San Diego: Plural publishing, Inc.
9. Suzuki, J.I, Tokyo (1988). Advances in audiology-Middle ear implant: Implantable hearing aids. Switzerland: Karger.
10. Valente, M., Hosford-Dunn, H., & Roeser, R.J. (2008). Audiology treatment. New York: Thieme Medical Publishers.


**Unit 2: Cochlear implants**


1. Clark, G., (2003). Cochlear implants - fundamentals & Applications. New York: Springer – AIP Press.
2. Clark, G., Tong, Y.C., & Patrick, F.J. (1990). Cochlear Prostheses. Edinburgh London Melbourne & New York: Church Hill Living stone.
3. Clark, M.G., R.S.C. Cowan & Dowell. R.C. (1997). Cochlear implantation for infants & children-advances. London: Singular Publishing Groups.
4. Cooper, H. (1995). Cochlear Implants –A practical guide. Delhi: AITBS Publishers.
5. Cullington, H.E. (2004). Cochlear implants-objective measures. London: Whurr Publishers.
6. Gifford, H.R. (2013). Cochlear implant patient assessment: Evaluation of candidacy, performance, and outcome. San Diego: Plural Publishing, Inc.
7. Hathiram Bachi, T., & Khattar Vicky, S. (2013). Atlas of operative otorhinolaryngology and head neck Surgery (Volume 1). New Delhi: Jaypee Brother Medical Publishers.
8. Kirwin, S.H. (2014). Cochlear Implants: Technological advances, psychological/social impacts and long-term effectiveness. Ney York: Nova Biomedical.
9. Thoutenhoofd, E.D., Archbold, S. M, Gregory S., Lutman, M E, Nikolopouls T.P. & Sach, T. H. (2005). Paediatric cochlear implantation-Evaluating Outcomes. London: Whurr Publishers.
10. McCormick, B., & Archbold, S. (2003). Cochlear implants for Young children. London: Whurr Publishers.

11. Niparko, J.K., Kirk, K.I., Mellon, N.K., Robbins, A.M., Tucci, D.L., & Wilson, B.S. editors. Cochlear Implants: Principles and Practices. Philadelphia: Lippincott: Williams & Wilkins, 2000.
12. Niparko, J. K. (2009). Cochlear Implants: Principles and practices. 2nd Edn. Philadelphia: Lippincott: Williams & Wilkins.
13. Ruckenstein, M. J. (2012). Cochlear implants and other implantable devices. San Diego: Plural publishing, Inc.
14. Tyler, R.S. (1995). Cochlear implants: Audiological foundations. New Delhi: AITBS Publishers.
15. Waltzman, S.B., & Cohen, N.L. (2000). Cochlear implants. New York: Thieme Medical Publishers.

**Unit 3: Mapping/Programming**

1. Clark, G., Tong, Y.C., & Patrick, F.J. (1990). Cochlear Prostheses. Edinburgh London Melbourne & New York: Churchill Livingstone.
2. Clark, M.G., R.S.C. Cowan, & Dowell, R.C. (1997). Cochlear implantation for infants & children-advances. London: Singular Publishing Groups.
3. Cooper, H. (1995). Cochlear Implants –A practical guide. Delhi: AITBS Publishers.
4. Hughes, M. L. (2013). Objective measures in cochlear implants. San Diego: Plural Publishing Inc.
5. Kirwin, S. H. (2014). Cochlear Implants: Technological advances, psychological/social impacts and long-term effectiveness. New York: Nova Biomedical.
6. Niparko, J. K. (2009). Cochlear Implants: Principles and practices. 2nd edn. Philadelphia: Lippincott Williams & Wilkins.
7. Ruckenstein, M. J. (2012). Cochlear implants and other implantable devices. San Diego: Plural publishing, Inc.
8. Tyler, R.S. (1995). Cochlear implant: Audiological foundations. New Delhi: AITBS Publishers.
9. Waltzman, S. B., & Roland, J.T. (2006). Cochlear implants. New York: Thieme Medical Publishers.
10. Waltzman, S.B., & Cohen, N.L. (2000). Cochlear implants. New York: Thieme Medical Publishers.
11. Wolfe, J., & Schafer, E. C. (2010). Programming Cochlear Implants. San Diego: Plural Publishing Inc.
12. Zeng, Popper & Fay (2004). Cochlear implants-Auditory Prostheses & Electric Hearing. New York: Springer-Verlag.

**Unit 4: Brain implant, mid-brain implants**

1. Allum, D.J., ((1996). Cochlear implant rehabilitation in children & Adults. London: Whurr Publishers Ltd.
2. Kim, C.S., Chang, S.O., & Lim, D. (2000). Updates in cochlear implantation. Switzerland: Karger.
3. Lim, H. H., Lenarz, M., & Lenarz, T., (2009). Auditory midbrain implant: A review. *Trends in Amplification*, Sept. 13(3), 149–180.

4. Clark, M.G., R.S.C. Cowan, & Dowell. R.C. (1997). Cochlear implantation for infants & children-advances. London: Singular Publishing Groups.
5. Cooper, H. (1995). Cochlear Implants –A practical guide. Delhi: AITBS Publishers.
6. Eisenberg, L.S. (2009). Clinical management of children with cochlear implants. United Kingdom: Plural Publishing.
7. Hathiram Bachi, T., & Khattar Vicky, S. (2013). Atlas of operative otorhinolaryngology and head neck Surgery (Vol. 1). New Delhi: Jaypee Brother Medical Publishers.
8. Niparko, J.K., Kirk, K.I., Mellon, N.K., Robbins, A.M., & Tucci, D.L., Wilson, B.S. editors. (2000). Cochlear Implants: Principles and Practices. Philadelphia: Lippincott: Williams & Wilkins.
9. Tyler, R.S. (1995). Cochlear implant: Audiological foundations. New Delhi: AITBS Publishers.
10. Waltzman, S.B., & Cohen, N.L. (2000). Cochlear implants. New York: Thieme Medical Publishers.
11. Ladd, P. (2003). Understanding Deaf Culture. Great Britain: Cromwell Press Ltd.

## Paper Code: AUD 3.2 - HC: Speech Perception

**Objectives:**

After completing this course, the candidate should be able to

1. Explain coding of speech in the auditory pathway in normal hearing individuals
2. Explain basic concepts regarding speech perception
3. Critically evaluate theories of speech perception and methods to synthesis speech
4. Describe the major and minor acoustic cues for speech perception in normal hearing individuals
5. Explain about speech perception in relation to short term memory
6. Describe aspects related to dichotic speech perception
7. Compare **adult,** infant and animal speech perception.

### Unit 1: Introduction to and theories of speech perception 18 Hrs

**1.1** Basic concepts.
- Differentiation of Hearing, Listening and Perception, Comprehension
- Overview on the acoustic cues of different classes of speech sounds

1.2 Categorical perception
- Definition
- Evidence for and against categorical and continuous speech perception

1.3 Normalization in speech perception
- Definition
- Methods used for normalization of vowels and consonants

1.4 Coding of speech in the auditory pathway
- Coding in the cochlea and auditory nerve
- Coding in the central auditory pathway

1.5 Theories of speech perception
- Acoustic theory
- Neurological theory
- Auditory theory
- Motor theory and its revisions
- Analysis-by-synthesis
- Dual stream theory
- Reverse hierarchy theory

### Unit 2: Perceptual cues for vowels and consonants 18 Hrs

2.1 Perception of vowels and diphthongs in normals:
- Major and minor cues to identify vowels and diphthongs
- Major and minor cues to differentiate vowels from diphthongs

2.2 Perception of consonants in normals:
- Major and minor cues to identify place, manner and voicing in: Stops, Fricatives, Affricates, Nasals
- Major and minor cues to differentiate between Stops, Fricatives, Affricates, Nasals

- Acoustical parameters used to differentiate vowels from consonants

**Unit 3: Speech synthesis, co-articulatory perception and perception of suprasegmentals 18 Hrs**

3.1 Methods used to synthesize speech for perceptual experiment
- Pattern play-back
- Analysis by synthesis
- Parametric synthesis
- Articulatory synthesis

3.2 Effects of co-articulation on speech perception:
- Basic concepts in coarticulation and methods to study coarticulatory perception
- Perception of vowels from consonantal segmental cues
- Perception of consonants from vowel segmental cues

3.3 Perception of suprasegmental cues in normal hearing individuals
- Perception of stress,
- Perception of rhythm
- Perception of intonation

**Unit 4: Factors related speech perception 18 Hrs**

4.1 Short term memory and speech perception
- Stages of memory, coding and capacity at the different stages
- Models of short term memory: Dual coding Model, Modal model, A model for auditory memory and contrast, Working memory model
- Role of short term memory in the perception of consonants and vowels

4.2 Dichotic listening
- Factors affecting dichotic perception
- Stimulus parameters
- Procedure parameters
- Subject parameters

4.3 Infant perception
- Methods of studying infant speech perception
- Theories of infant speech perception: Universal theory, Attunement theory, Perceptual Learning theory, Maturational theory, perceptual magnetic theory
- Studies to support the theories
- Perception of consonants and vowels in infants
- Comparison of adult and infant perception

4.4 Animal speech perception
- Overview on methods to study animal speech perception
- Need to study animal
- Perception of consonants and vowels
- Categorical perception and normalization
- Animal Vs. human perception

**Practicum:**

1. Observe the spectra, waveforms and spectrograms of various vowels and consonants and note down your observations
2. Note down the difference in the perception of consonants/vowels are truncated from CVC or VCV
3. Synthesize stop consonants using analysis by synthesis, parametric synthesis and articulatory synthesis
4. Use synthesized VOT continuum and F2 transition continuum to study categorical perception using discrimination and identification tasks
5. Note down the cross linguistic differences in speech perception in at least two languages.
6. Test recency and precedence using words

**Common Reference:**


1. Ainsworth, W.A. (1976). Mechanism of speech recognition.International series in natural philosophy. Vol. 85, Oxford: Pergamon Press.
2. Berlin, C. (1984). Hearing science. California: College-Hill Press, Inc.
3. Border, G. J., & Harris, K. S. (1980). Speech sciences primer: physiology, acoustic and perception of speech. London: Williams and Wilkins.
4. Baddeley, A. D. (1986). *Working Memory*. Clarendon Press.
5. Raphael, L. J., Borden,G. J.,& Harris K. S. (2011). *Speech Science Primer: Physiology, Acoustics, and Perception of Speech* (Sixth edition). Baltimore, MD: LWW.
6. Eggermont, J. J. (2001). Between sound and perception: reviewing the search for a neural code. *Hearing Research*, *157*(1-2), 1–42.
7. Flanagan, J. L. (1965). *Speech Analysis Synthesis and Perception*.Springer-Verlag.
8. Greenberg, S., Ainsworth, W. A., & Fay, R. R. (Eds.).(2004). *Speech Processing in the Auditory System*. New York: Springer.
9. Raphael, L. J., Borden, G. J., & Harris, K. S. (2007).*Speech Science Primer: Physiology, Acoustics, and Perception of Speech*. Lippincott Williams & Wilkins.
10. Kent, R. D. (2002). *Acoustic Analysis of Speech* (2nd Revised edition edition). Australia ; United States: Delmar Cengage Learning.
11. Mildner, V. (2007).*The Cognitive Neuroscience of Human Communication* (1 edition). New York: Psychology Press.
12. Moore, B., Tyler, L., &Marslen-Wilson, W. (2009).*The Perception of Speech: From Sound to Meaning*. OUP Oxford.
13. Raphael, L. J., Borden, G. J., & Harris, K. S. (2011).*Speech Science Primer: Physiology, Acoustics, and Perception of Speech* (Sixth edition). Baltimore, MD: LWW.

14. Pickett, J. M. (1998). *The Acoustics of Speech Communication: Fundamentals, Speech Perception Theory, and Technology* (1 edition). Boston: Pearson.
15. Sanders, D. A. (1977).*Auditory Perception of Speech: An Introduction to Principles and Problems*. Englewood Cliffs, N.J: Prentice Hall.
16. Studdert-Kennedy, M., & Mattingly, I. G. (Eds.). (1990). *Modularity and the Motor theory of Speech Perception: Proceedings of A Conference ToHonor Alvin M. Liberman* (1 edition). Hillsdale, N.J: Psychology Press.
17. Tatham, M., & Morton, K. (2011).*A Guide to Speech Production and Perception* (1 edition). Edinburgh: Edinburgh University Press.
18. Pisoni, D. B., &Remez, R. E. (Eds.). (2005). The Handbook of Speech Perception. In *The Handbook of Speech Perception*. Blackwell Publishing Ltd.
19. Kent, R. D. & Read, C. (1995).The acoustic analysis of speech. New Delhi: AITBS Publishers and distributors.
20. Sanders, D.A (1977).Auditory perception of speech - an introduction to principle and problems. New Jersey: Prentice Hall.

**Unit 1: Introduction to and theories of speech perception**

1. Ahissar, M., Nahum, M., Nelken, I., & Hochstein, S. (2009). Reverse hierarchies and sensory learning. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1515), 285-299.
2. Dehaene-Lambertz, G., Pallier, C., Serniclaes, W., Sprenger-Charolles, L., Jobert, A., &Dehaene, S. (2005). Neural correlates of switching from auditory to speech perception. *Neuroimage,* 24 (1), 21-33.
3. Eggermont, J. J. (2001). Between sound and perception: reviewing the search for a neural code.Review, *Hearing Research*, 157(1-2), 1-42.
4. Flanagan, Frisina, R. D. (2001). Subcortical neural coding mechanisms for auditory temporal processing.Review, *Hearing Researh,* 158 (1-2), 1-27.
5. Frank, E.M., & Jane, A.B. (1985).Neuroanatomy, Neurophysiology and Central auditory assessment, *Ear and Hearing*, 283-293.
6. Guenther, F. H., Nieto-Castanon, A., Ghosh, S. S., &Tourville, J. A. (2004).Representation of sound categories in auditory cortical maps.*Journal of Speech Language and Hearing Research,* 47(1), 46-57.
7. Hickok, G., &Poeppel, D. (2007).The cortical organization of speech processing.*Nature Reviews Neuroscience, 8*(5), 393–402.
8. Hickok, G. (2014). *The Myth of Mirror Neurons - The Real Neuroscience of Communication and Cognition*. New York: W. W. Norton & Company.
9. Schouten, M. E, & Van Hessen, A. J. (1992).Modeling phoneme perception. I: Categorical perception. *Journal of the Acoustical Society of America,* 92 (4), 1841-1855.
10. Strange, W. (1989).Evolving theories of vowel perception.-Review.*Journal of the Acoustical Society of America,* 85 (5), 2081-2087.

**Unit 3: Speech synthesis, coarticulatory perception and perception of suprasegmentals**


1. Beckman, M., & Shoji, A. (1984).Spectral and perceptual evidence for CV coarticulation in devoiced /si/ and /syu/ in Japanese.*Phonetica,* 41 (2), 61-71.
2. Bell-Berti, F., & Harris, K. S. (1979). Anticipatory co articulation: some implications from a study of lip rounding. *Journal of the Acoustical Society of America,* 65 (5), 1268-1270.
3. Benguerel, A. P., & McFadden, T. U. (1989).The effect of co articulation on the role of transitions in vowel perception.*Phonetic,*46 (1-3), 80-96
4. Gottfried, T. L, & Strange, W. (1980).Identification of coarticulated vowels.*Journal of the Acoustical Society of America,* 68 (6), 1626-1635.
5. Katz, W. F., Kripke, C., &Tallal, P. (1991). Anticipatory co articulation in the speech of adults and young children: acoustic, perceptual, and video data. *Journal of Speech and Hearing Research,* 34 (6), 1222-1232.
6. Lotto, A.J., &Kluender, K.R. (1998). General contrast effects in speech perception: effect of preceding liquid on stop consonant identification. *Perceptual Psychophysics,* 60 (4), 602-619.
7. Nittrouer, S., &Studdert-Kennedy, M. (1987).The role of co-articulatory effects in the perception of fricatives by children and adults. *Journal of Speech and Hearing Research,* 30 (3), 319-329.
8. Repp, B. H, & Mann, V. A. (1981).Perceptual assessment of fricative--stop coarticulation.*Journal of the Acoustical Society of America,* 69 (4), 1154-1163.
9. Repp, B. H., & Mann, V. A. (1982). Fricative-stop co articulation: acoustic and perceptual evidence. *Journal of the Acoustical Society of America,* 71 (6), 1562-1567.


**Unit 4: Factors related speech perception**


1. Berlin, C.I & Cullen, J.K. (1975). Dichotic sings of speech mode listening. In A. Cohen & S.G. Nooteboom (Eds.), structural and process in speech perception. New York: Springer-Verlag.
2. Bohn, O. S., & Polka, L. (2001).Target spectral, dynamic spectral, and duration cues in infant perception of German vowels.*Journal of the Acoustic Society of America,*110 (1), 504-515.
3. David B. Pisoni (1973). Auditory and phonetic memory codes in the discrimination of consonants and vowels. *Perception & psychophysics*, 13 (2), 253-260.
4. David, B. Pisoni (1979). Auditory short-term memory and vowel perception.*Memory & cognition,* 3(1) 7-18.
5. Eliers& Morse (1981).Discrimination of VOT in infancy.*Journal of Acoustic Society of America.*
6. Fowler, C. A., Best, C. T., &McRoberts, G. W. (1990). Young infants' perception of liquid coarticulatory influences on following stop consonants. *Perceptual Psychophysics,*48 (6), 559-570.

7. Goodman, J.C. &Nusbaum.(Eds.), (1994). The development of speech perception: the transition from speech sounds to spoken words. London: A Bradford Book, The MIT Press.
8. Kuhl, P. K., Stevens, E., Hayashi. A., Deguchi, T., Kiritani, S., Iverson, P. (2006). Infants show a facilitation effect for native language phonetic perception between 6 and 12 months. *Developmental Science,* 9 (2), F13-F21.
9. Rintleman. (1991). Hearing assessment. Allyn and Bacon.PRO-ED, Inc.
10. Walley, Aslin&Pisoni (1984). Infant discrimination of 2 and 5 formant stop consonants differing in place of articulation. *Journal of Acoustic Society of America*

## Paper Code: AUD 3.3 - HC: Seminars in Assessment of Hearing Impairment

**Objectives:**

After completing this course, the student shall be able to describe:

1. Sign and Symptoms related to various peripheral and central auditory disorders.
2. The test battery for differential diagnosis of various auditory disorders.
3. The relationship between histopathology of the disorder and audiological test findings.
4. The different non-audiological tests and their importance in diagnosis of various auditory disorders.
5. The findings, pathophysiology, probable cause and counsel regarding appropriate management options to the clients.

**Unit 1: Correlation of audiological findings to histopathological findings in conductive hearing loss 18 Hrs**

1.1 Disorders of pinna and external auditory canal
1.2 Disorders of tympanic membrane
1.3 Disorders of ossicular chain
1.4 Other disorders related to middle ear cavity including tumors of the middle ear

**Unit 2: Audiological findings and its relationship to histopathological findings cochlear and retrocochlear pathologies 18 Hrs**

2.1 Cochlear pathologies-Mineres disease, presbycusis, ototoxicity, noise induced hearing loss, sudden sensorineural hearing loss, systemic diseases, autoimmune disorders

2.2 Retrocohlear pathologies-Space occupying lesions, auditory nerve tumors, auditory neuropathy, Other demyelinating disorders

**Unit 3: Assessment of hearing in individuals with co-existing conditions 18 Hrs**

3.1 Assessment of auditory disorders in the special population such as
- Deaf-blind
- Intellectually challenged
- Pervasive developmental disorders
- Cerebral palsy

3.2 Assessment of patients with hyperacusis
- Conditions/disorders in which it occurs
- Tests and interpretation
- Implications of the findings in rehabilitation

3.3 Assessment of patients with Vestibular problems
- Condition/disorders in which it occurs
- Tests, interpretation
- Implications of findings in rehabilitation

3.4 Assessment of patients with Tinnitus
- Condition associated with tinnitus

- Types of tinnitus
- Evaluation
- Implications of findings in rehabilitation

**Unit 4: Genetic hearing loss and non-audiological evaluations 18 Hrs**

4.1 Genetic hearing loss
- Basics of Genes and genetic hearing loss
- Audiological and non-audiological tests for identifying genetic hearing loss,
- Gene mapping, amniocentesis
- Gene therapy
- Genetic counselling

4.2 Non-audiological tests
- Clinical neurological examination
- X-rays
- CT Scan
- MRI
- FMRI
- PET
- SPECT

4.3 Lab tests for differential diagnosis of auditory disorders

**Practicum:**

1. Administration and interpretation of various audiological tests on individuals with simulated conductive pathology (2 participants).
2. Administration and Interpretation of various audiological tests on individuals with simulated cochlear pathology (2 participants).
3. Administration and Interpretation of various audiological tests on individuals with various retrocochlear pathology (5 participants).
4. Administration and Interpretation of various tests of Tinnitus in normal subjects (2 participants).
5. Administration and Interpretation of various vestibular tests on normal hearing individuals (2 participants).

**Reference:**

**Unit 1: Correlation of audiological findings to histopathological findings in conductive hearing loss**

1. R. Sataloff & Sataloff (1993). Hearing Loss. USA: Informa Health Care
2. Hall, J.W., & Mueller, H.G. (1997) Audiologists' Desk Reference. Volume 1: Diagnostic Audiology Principles, Procedures and Protocols. San Diego: Singular Publishing Group.
3. Hull, R.H. (1995). Hearing in aging. San Diego: Singular Publishing Group Inc.
4. Mencher, G.T., Gerber, S.E., & McCombe, A. (1997) Audiology and Auditory Dysfunction. Boston: Allyn and Bacon.

5. Musiek, F.E., Baran, J.A., & Pinherio, M.L. (1994) Neuro Audiology: Case studies, San Diego: Singular Publishing Group.
6. Roland, P.S., Marple, B.F., & Meyerhoff, W.L. (1997). Hearing loss. New York: Thieme Medical Publishers.
7. Roser, R.R., Valente, M., & Hosford-Dunn, D. (Eds.) (2000). Audiology: Diagnosis. New York: Thieme Medical Publishers.
8. Ross, R.J. (1996). Roeser's Audiology Desk reference: A guide to the Practice of Audiology. New York: Thieme Medical Publishers.
9. Van De Water, T.R., Popper, A.N., & Fay. R.R. (Ed.) (1996). Clinical aspects of hearing. New York: Springer.

**Unit 2: Audiological findings and Its relationship to histopathological findings cochlear and retrocochlear pathologies**

1. R. Sataloff & Sataloff (1993). Hearing Loss. Informa Health Care.
2. Hall, J.W., & Mueller, H.G. (1997) Audiologists' Desk Reference. Vol. 1: Diagnostic Audiology Principles, Procedures and Protocols. San Diego: Singular Publishing Group.
3. Hull, R.H. (1995). Hearing in aging. San Diego: Singular Publishing Group Inc.
4. Patrick J. Willams (2004). Genetic Hearing Loss. New York: Marcel Decker Inc.
5. Hayes, D., & Northern, J.L. (1996). Infants and Hearing. San Diego: Singular Publishing Group.
6. Musiek, F.E., Baran, J.A., & Pinherio, M.L. (1994) Neuro Audiology: Case studies. San Diego: Singular Publishing Group
7. Roland, P.S., Marple, B.F., & Meyerhoff, W.L. (1997). Hearing loss. New York: Thieme Medical Publishers.
8. Roser, R.R., Valente, M., & Hosford-Dunn, D. (Eds.) (2000). Audiology: Diagnosis. New York: Thieme Medical Publishers.
9. Ross, R.J. (1996). Roeser's Audiology Desk reference: A guide to the Practice of Audiology. New York: Thieme Medical Publishers
10. Stanely A. Gelfand (2009). Essentials of Audiology. New York: Theime Medical Publishers.
11. Statloff & Sataloff (2006). Occupational Hearing Loss. New York: Tayler and Francis.
12. Katz, J. et al. (Ed.). (1994). Handbook of Clinical Audiology. Baltimore: Williams and Wilkins.
13. Mencher, G.T., Gerber, S.E. & McCombe, A. (1997) Audiology and Auditory Dysfunction, Boston: Allyn and Bacon.
14. Van De Water, T.R., Popper, A.N., & Fay, R.R. (Ed.) (1996). Clinical aspects of hearing. New York: Springer.

**Unit 3: Assessment of hearing in individuals with co-existing conditions**

1. R S. Tyler (2000). Tinnitus Handbook. CA: Singular Publishers
2. Luxon, L.M., & Davies, R.A. (Eds.) (1997). Handbook of vestibular rehabilitation. San Diego: Singular Publishing Group, Inc.
3. Desmond, A. L. (2004). Vestibular function assessment and management. New York: Theime Medical Publishers.

4. Highstein, S. M., Fay, R. R., & Popper, A. N. (2004). The vestibular system. Springer Series.
5. Weber, P. C. (2008). Vertigo and disequilibrium. New York: Theime Medical Publishers.
6. Vernon, J. A. (1998). Tinnitus: Treatment and Relief. Boston: Allyn and Bacon
7. Gary P. Jacobson & Neil T. Shepard. (Ed.) (2008). Balance function assessment and management. San Diego: Plural Publishing Inc.

**Unit 4: Genetic hearing loss and non-audiological evaluations**

1. Kingsley, R.E. (1996). Concise text of neuro-science. Philadelphia: Williams and Wilkins.
2. Martini, A, et al. (Eds.) (1996) Genetics and Hearing impairment, London: Whurr Publishers.
3. Shprintzen, R.J. (1997). Genetic, Syndromes and communication disorders. San Diego: Singular Publishing Group Inc.
4. Willems P J. (2004). Genetic Hearing loss. USA: Marcel Deckeer Inc.
5. Dalebout S (2009). The Praeger Guide to Hearing and Hearing Loss.USA: Greenwood Publishing Corporation.
6. Toriello H V., & Smith S D. (2013). Hereditary Hearing Loss and Its Syndromes. United Kingdom: Oxford University Press.
7. Flexer C A (2008). Pediatric Audiology: Diagnosis, Technology, and Management. New York: Thieme Medical Publishers.

## Paper Code: AUD 3.4 - HC: Seminars in Rehabilitative Audiology

**Objectives:**

At the end of the course, the student shall

1. Know about various types of recent devices and advances in technology with respect to amplification/assistive devices.
2. Know selection strategies and optimization of hearing aids, critically review selection procedures of the hearing device
3. Be able to prepare the programs and intervention strategies as per the different needs of the clients having different auditory disorders across different age groups
4. List specific needs and know psychosocial and communicative demands and strategies to solve these

**Unit 1: Advances in hearing aid and hearing assistive technology 18 Hrs**

1.1 Application of recent advances in hearing aids and hearing assistive technology (HAT)
- Compression and expansion, directionality, advanced signal processing techniques including noise reduction algorithms, wireless technology, data logging, trainable hearing aids, occlusion reduction, application of nanotechnology in hearing aids, others
- Speech cue enhancement – spectral shape, duration, intensity, enhancement of CVR, speech simplification, re-synthesis
- Enhancement of perception through telephone/mobile phone
- Techniques to control acoustic feedback, distortion, circuit noise.
- Electromagnetic interference – measurement, solutions; techniques to improve compatibility of hearing aids with mobile phones

1.2 Application of LASER technology in ear mould production, ear mould modifications – physical and acoustic modification;

1.3 Electroacoustic measurement of hearing aids
- Advanced methods in electro-acoustic measurements of hearing aids including directionality, group and phase delay, DNR algorithm, and ALDs
- Variables affecting electroacoustic measurements
- Comparison of International and Indian standards/legislations for hearing aids and ALDs.

**Unit 2:Fitting of hearing aid and hearing assistive devices 18 Hrs**

2.1 Selection, verification and validation of hearing aids and hearing assistive devices.
- Pre-selection: Factors affecting pre-selection, assessment of listening needs of the individuals with hearing impairment
- Critical analysis of hearing aid selection procedures: Prescriptive and comparative procedures
- Objective procedures for hearing aid fitting (ABR, ALLR, ASSR and others)
- Hearing aid programming and optimization

- Hearing aid verification using insertion gain measurements and sound field measurement including verification of advanced features
- Validation

2.2 Hearing aid fitting for children

- Special considerations while fitting hearing aids for infants and children in terms of pre-selection, selection, verification (including advanced features) and validation
- Different protocols used (Minnesota early hearing detection and intervention (EHDI) program, American Academy of Audiology clinical practice guidelines)

2.3 Hearing aid fitting considerations for older adults

2.4 Management of other hearing disorders

- Sudden hearing loss, unilateral hearing loss
- High frequency hearing loss
- Cochlear dead region, auditory dysynchrony, management of auditory dysynchrony vs. CAPD
- Cerumen management

2.5 Fitting of HATs

- Pre-selection: Factors affecting pre-selection, assessment of needs for HAT
- Selection, verification and validation of HATs for different age groups

2.6 Future trends in hearing aids and HATs: Technology and fitting strategies

**Unit 3: Rehabilitation of individuals with hearing impairment 18 Hrs**

**3.1** Counselling the hearing aid and HAT users

- Overview to counselling theories/techniques
- Realistic expectations, adjusting to hearing device, other management options
- Care and maintenance of HATs for individuals with different age groups
- Trouble shooting and fine tuning/optimization of hearing aids and HAT

3.2 Management of children with hearing impairment

- Criteria for selecting different auditory listening programs; using an eclectic approach in providing listening training; criteria for transition from one method to the other as a child grows
- Adapting AVT techniques for Indian languages and late identified children
- Providing group listening training activities for children having different listening skills
- Selection of language for training based on native language and regional language

3.3 Rehabilitation of adults and older adults

- Justification for providing auditory listening / speech reading training for older adults including auditory plasticity
- Techniques for adults and older adults
- Variables that affect the communication and the role of the communication partner
- Planning training activities; assertiveness training

3.4 Measuring therapy outcome

- Importance of outcome
- Measurement of therapy outcome for different age groups

- Comparison of outcome across different methods of training

**Unit 4: Rehabilitation of multiple handicapped and tinnitus 18 Hrs**

4.1 Management of the children/adult with multiple handicapped

- Hearing aid fitting considerations, strategies used and the outcome with different strategies for individuals with hearing impairment with visual problems; cognitive problems; neuro-motor problems

4.2 Audiological management of tinnitus

- Models related to tinnitus management: patho-physiological and neurophysiological model
- Overview to non-audiological management techniques for tinnitus
- Audiological management techniques for those with normal hearing and different degrees of hearing loss (TRT, counselling, others) and their outcomes

4.3 Audiological management of hyperacusis

- Models related to hyperacusis management; overview to non-audiological management techniques for hypercusis
- Audiological management techniques for normal hearing and different degrees of hearing loss and their outcomes

**Practicum:**

- To carry out electro-acoustic measurements of digital hearing aids including directionality, group and phase delay, DNR algorithms, and HATs; comparison of EAC across different standards and write down the observations (1 hearing aid).
- To program advanced features of recent digital hearing aids (2 hearing aids).
- To carry out insertion gain measurements and RECD measurements (2 individuals).
- To watch videos on AVT and discuss strategies used.
- To collect and observe the videos of counseling the patients with tinnitus and hyperacusis.

**References:**

**Unit 1: Advances in hearing aid and hearing assistive technology**

1. Atcherson, S. R., Franklin, C. A., & Smith-Olinde, L. (2015). Hearing assistive and access technology. San Diego: Plural Publishing Inc.
2. Dillon, H. (2012). Hearing Aids. 2nd Edn. Australia: Boomerang Press.
3. Hersh, M. A., & Johnson, M. A. (2003). Assistive Technology for the hearing-impaired, Deaf and Deaf-blind. Nottingham: Springer-Verlag London Ltd.
4. Martini, A., Mazzoli, M., Read, A., & Stephens, D. (2001). Definitions, Protocols and Guidelines in Genetic Hearing Impairment. England: Whurr Publishers Ltd.
5. Martini, A., Read, A., & Stephens, D. (1996). Genetics and hearing impairment. England: Whurr Publishers Ltd.

6. Metz, M. J. (2014). Sandlin's textbook of hearing aid amplification. 3rd Edn. San Diego: Plural publishing Inc.
7. Moser, P. J. (2009). Electronics and Instrumentation for Audiologists. Unites States of America: Taylor & Francis Group.
8. Salvi, R.J., Henderson, D., Franco, F., & Vittorio, C. (1996). Auditory system Plasticity and Regeneration. New York: Thieme Medical Publishers Inc.
9. Sandlin, R.E. (2000). Textbook of Hearing aid amplification. London: Singular Publishing Group.
10. Schaub, A. (2008). Digital hearing aids. New York: Thieme Medical publishers.
11. Tyler, R.S., & Schum, J. (1995). Assistive devices for persons with hearing impairment. United States of America: Allyn & Baccon.
12. Valente, M., & Hosford-Dunn. H. (2000). Audiology Treatment. New York: Thieme Medical Publishers.
13. Valente, M. (1996). Hearing aids: Standards, Options & Limitations. New York: Thieme Medical Publishers.
14. Willems, P. J. (2004). Genetic hearing Loss. United States of America: Marcel Dekker Inc.

**Unit 2: Fitting of hearing aid and hearing assistive devices**

1. Dillon, H. (2012). Hearing Aids, 2nd edn. Australia: Boomerang press.
2. Goldenberg, R.A. (1996). Hearing aids- A manual for clinicians. New York: Lippincott-Raven Publishers.
3. Mueller, H.G., Hawkins, D.B., & Northern, J. L. (1992). Probe microphone measurement-hearing aid selection & assessment. California: Singular Publishing Group.
4. Metz, M. J. (2014). Sandlin's textbook of hearing aid amplification. 3rd edn. San Diego: Plural publishing Inc.
5. Mueller, H. G., Rickettes, T. A., & Bentler, R. (2014). Morden hearing aids: Pre-fitting Testing and selection considerations. San Diego: Plural Publishing Inc.
6. Sandlin, R.E. (1995). Handbook of Hearing aid amplification – clinical consideration and fitting practices. London: Singular Publishing Group.
7. Schow, R.L., & Nerbonne, M.A. (2007). Introduction to Audiologic Rehabilitation. United States of America: Pearson Education Inc.
8. Tye-Murray, N. (2009). Foundations of Aural rehabilitation- Children, Adults & Their family members. United States of America: Delmar, Cengage Learning.
9. Tyler, R.S., & Schum, J. (1995). Assistive devices for persons with hearing impairment. United States of America: Allyn & Baccon.
10. Valente, M., & Hosford-Dunn, H. (2000). Audiology Treatment. New York: Thieme Medical Publishers.

**Unit 3: Rehabilitation of individuals with hearing impairment**

1. Alpiner, J.G., & McCarthy, P.A. (2000). Rehabilitative Audiology-Children & Adults. United States of America: Lippincott Williams & Wilkins.
2. Cole, E.B., & Carol, F. (2007).Children with hearing loss- Developing Listening & Talking. United States of America: Plural Publishing Inc.

3. Estabrooks, W. (2006). Auditory Verbal Therapy & Practice. United States: Alexander Graham Bell Association for the Deaf and Hard of Hearing Inc.
4. Hogan, A. (2001). Hearing Rehabilitation for deafened adults. London & Philadelphia: Whurr Publishers.
5. Hull, R. H. (2014). Introduction to aural rehabilitation. 2nd edn. San Diego: Plural publishing Inc.
6. Johnson, C. E. (2012). Introduction to auditory rehabilitation: A contemporary issues approach. New Jersy: Pearson Education Inc.
7. Kriscos, P.B., & Lesner, S.A. (1995). Hearing care for the older Adult-Audiologic rehabilitation. United States of America: Butterworth-Heinemann.
8. Metz, M. J. (2014). Sandlin's textbook of hearing aid amplification. 3rd Edn. San Diego: Plural Publishing Inc.
9. Montano, J. J. (2014). Adult aural rehabilitation. 2nd Edn. San Diego: Plural Publishing Inc.
10. Roeser, R.J., & Downs, M.P. (2004). Auditory disorders in school children. New York: Thieme Medical Publishers Inc.
11. Sanders, D.A. (1982). Aural Rehabilitation-A Management Model. United States of America: Prentice Hall Inc.
12. Schow, R.L., & Nerbonne, M.A. (2007). Introduction to Audiologic Rehabilitation. United States of America: Pearson Education Inc.
13. Tye-Murray, N. (2015). Foundations of aural rehabilitation-Children, Adults & Their family members. 4th Edn. United States of America: Stamford, Cengage Learning.

**Unit 4: Rehabilitation of multiple handicapped and tinnitus**

1. Alpiner, J.G., & McCarthy, P.A. (2000). Rehabilitative Audiology-Children & Adults. United States of America: Lippincott Williams & Wilkins.
2. Baguley, D. M., & Andersson, G. (2007). Hyperacusis: Mechanisms, Diagnosis and Therapies. San Diego: Plural Publishing Inc.
3. Hersh, M. A., & Johnson, M. A. (2003). Assistive Technology for the hearing-impaired, Deaf and Deaf-blind. Nottingham: Springer-Verlag London Ltd.
4. Hull, R. H. (2014). Introduction to aural rehabilitation, 2nd Edn. San Diego: Plural Publishing Inc.
5. Jastreboff, P.J., & Hazell, J.W.P. (2004). Tinnitus retraining therapy-implementing the Neurophysiological model. United Kingdom: Cambridge University Press.
6. Johnson, C. E. (2012). Introduction to auditory rehabilitation: A contemporary issues approach. New Jersy: Pearson Education, Inc.
7. Metz, M. J. (2014). Sandlin's textbook of hearing aid amplification. 3rd Edn. San Diego: Plural Publishing, Inc.
8. Montano, J. J. (2014). Adult aural rehabilitation. 2nd Edn. San Diego: Plural Publishing Inc.
9. Roeser, R.J., & Downs, M.P. (2004). Auditory disorders in school children. New York: Thieme Medical Publishers Inc.
10. Sanders, D.A. (1982). Aural Rehabilitation-A Management Model. United States of America: Prentice Hall Inc.
11. Schow, R.L., & Nerbonne, M.A. (2007). Introduction to Audiologic Rehabilitation. United States of America: Pearson Education Inc.

12. Tye-Murray, N. (2015). Foundations of aural rehabilitation-Children, Adults & Their family members. 4th Edn. United States of America: Stamford, Cengage Learning.
13. Valente, M., & Hosford-Dunn, H. (2000). Audiology treatment. New York: Thieme Medical Publishers Inc.
14. Wong, L., & Hickson, L. (2012). Evidence-based practice in audiology: Evalauting interventions for children and adults with hearing impairment. San Diego: Plural Publishing Inc.

## Paper Code: AUD 3.5 a - SC: Vestibular System: Assessment and Management

**Objectives:**

After passing this course, the student should be able to

1. Describe the anatomy and physiology of the human vestibular system
2. Perform the tests for vestibular assessment and interpret the results
3. Identify various vestibular pathologies and differentially diagnose one from the others
4. Carry-out vestibular rehabilitation and make appropriate referrals

**Unit 1: Anatomy & physiology of the systems involved in balance maintenance 12 Hrs**

1.1 Anatomy and physiology of peripheral vestibular system
- Semicircular canals
- Utricle
- Saccule
- Vestibular nerve

1.2 Anatomy of the central vestibular pathway and its connections
- Brainstem
- Cerebellum
- Vestibular cortex

1.3 Reflexes involving the vestibular system
- Vestibulo-ocular reflex- pathways from each of the semicircular canals, cranial nerves involved (cranial nerves II, IV and V)
- Vestibulo-spinal reflex
- Sacculocollic reflex

1.4 Other systems involved in balance
- Proprioceptive (somatosensory) system- location of various receptors, strategies used for maintaining balance like ankle, hip, and step strategies
- Visual system: Various kinds of eye movements like gaze, saccade, optokinetic and pursuit

1.5 Association between vestibular system and cognition

**Unit 2: Assessment of vestibular system 15 Hrs**

2.1 Questionnaire based assessments

- Questionnaires for screening and diagnosis (Standard case history, Vertigo symptom scale, Motion sensitivity quotient)
- Questionnaires for quality of life assessment (Dizziness handicap inventory, Activities-specific balance confidence scale, Vestibular disorders activities of daily living, visual analog scales)

2.2 Behavioral tests for bedside assessment, and diagnosis- background, technique involved, interpretation and usefulness

- Romberg test
- Fukuda stepping test
- Tandem gait test
- Past pointing test (Finger-to-nose test)
- Tests for cerebellar function (Alternate pronation-supination of palm, tracking of shin bone by the heel, use of appropriate strategies to pick up objects)
- Head impulse test
- Head shake test
- Glycerol test

2.3 Physiological/electrophysiological tests- background, technique involved, interpretation and usefulness

- Rotatory chair test (sinusoidal harmonic acceleration, visual-vestibular interaction tests, vestibular ocular reflex suppression test, step velocity test)
- Craniocorpography
- Computerized dynamic posturography
- Ocular motility testing using ENG/VNG (gaze, optokinetic, saccade and pursuit)
- Positional/positioning tests
- Caloric test using ENG/VNG (monothermal, bithermal and Cobrax test; use of Alexander's law)
- VEMP (cervical, ocular and other variants)
- Sclera coil search test
- Video head impulse test
- Subjective visual vertical and horizontal tests
- Vestibular autorotation test

**Unit 3: Disorders of the vestibular system** **15 Hrs**

3.1 Diseases of the vestibular labyrinth

- Meniere's disease
- Benign paroxysmal positional vertigo
- Labyrinthitis
- Perilymph fistula
- Superior semicircular canal dehiscence
- Diabetes mellitus

3.2 Diseases of the nerve

- Vestibular neuritis
- Auditory neuropathy spectrum disorders
- Vestibular schwannomas
- Diabetes mellitus

3.3 Diseases of the central nervous system

- Generalized neuropathy involving multiple systems
- Multiple sclerosis
- Tumors of CP angle and other cranial tumors
- Cerebro-vascular accidents involving vestibular cortex and cerebellum
- Vertebro-basilar insufficiency

- Migraine
- Meningitis and encephalitis

3.4 Age-related degeneration

3.5 Vestibular disorders in children

**Unit 4: Management of vestibular dysfunction 12 Hrs**

4.1 Treatments for unilateral and bilateral vestibular loss

4.2 Medical and surgical management of vertigo
- Vestibular suppression
- Dietary modifications
- Surgeries

4.3 Non-medical management of vertigo
- Brandt-Daroff exercises for positional vertigo
- Repositioning maneuvers for BPPV (Epley maneuver, Semont liberatory maneuver, Canalith repositioning maneuver, Gans repositioning maneuvers, Barbeque roll maneuver, Appiani maneuver, Guffoni liberatory maneuver)
- Other vestibular rehabilitation exercises

4.4 Rehabilitation of children with disequilibrium

**Practicum:**

1. Watch videos and slides of vestibular system's anatomy and physiology.
2. Perform behavioral balance assessment using Romberg test, Fukuda stepping test, Tandem gait test, past pointing tests on 10 healthy individuals.
3. Perform tests for cerebellar function like alternate pronation-supination of palm, tracking of shin bone by the heel, use of appropriate strategies to pick up objects on 5 healthy individuals.
4. Perform head impulse test, head shake test and subjective visual vertical (bucket test) on 5 healthy individuals.
5. Obtain cVEMP and oVEMP from 5 healthy individuals.
6. Perform vHIT on 5 healthy individuals.
7. Carry out tests for peripheral and central vestibular dysfunction (ocular motility testing) using ENG/VNG on 5 healthy individuals.
8. Observe the procedure for bithermal caloric test.
9. Watch the videos of various repositioning maneuvers and vestibular rehabilitation exercises and administer them on 5 healthy individuals.
10. Write reports about all the above.

**References:**

**Unit 1: Anatomy & physiology of the systems involved in balance maintenance**


1. Ackley, R. S., Decker, T. N., & Limb, C. J. (2007). An essential guide to hearing and balance disorders. New Jersey: Lawrence Erlbaum Associates Inc. Publishers.
2. Biswas, A. (1998). An introduction to neurotology. Mumbai, India: Bhalani Publishing House.
3. Claussen, C. F., De Sa, J. V., Estelrrich, P. & Kirtane, M. V. (1978). Clinical study of human equilibrium by electronystagmo- graphy and allied tests. Bombay, India: Popular Prakashan.
4. Desmond, A. L. (2004). Vestibular function: evaluation and treatment. New York: Thieme Medical Publishers Inc.
5. Deviterne, D., Gauchard, G. C., Jamet, M., Vancon, G., & Perrin, P. P. (2005). Added cognitive load through rotary auditory stimulation can improve the quality of postural control in the elderly. *Brain Research Bulletin*, 64, 487-492.
6. Furman, J. M., Cass, S. P., & Whitney, S. L. (2010). New York: Oxford University Press Inc.
7. Guidetti, G. (2013). The role of cognitive processes in vestibular disorders. *Hearing, Balance and Communication*, 11, 3-35.
8. Hitier, M., Besnard, B., & Smith, P. F. (2014). Vestibular pathways involved in cognition. Frontiers in Integrative Neuroscience, 8(59), 1-16. doi: 10.3389/fnint.2014.00059
9. Hughes, G. B., & Pensak, M. L. (2007). Clinical Otology. New York: Thieme Publishers, Inc.
10. Jackler, R. K., & Brackmann, D. E. (2005). Neurotology. 2nd Ed. Philadelphia: Elsevier Mosby.
11. Jacobson, G. P., & Shepard, N. T. (2008). Balance function assessment and management. San Diego: CA: Plural Publishing Inc.
12. McCaslin, D. L. (2013). Electronystagmography and videonystagmography ENG / VNG. San Diego: Plural Publishing Inc.
13. Shepard, N. T., & Telian, S. A. (1997). Practical management of the balance disorders patient. New York: Thomson Delmar Learning.
14. Woollacott, M., & Shumway-Cook, A. (2002). Attention and the control of posture and gait: A review of an emerging area of research. *Gait and Posture*, 16, 1-14.


**Unit 2: Assessment of vestibular system**


1. Biswas, A. (1998). An introduction to neurotology. Mumbai, India: Bhalani Publishing House.
2. Biswas, A. (2009). Clinical audio-vestibulometry for otologists and neurologists. 4th Ed. Mumbai, India: Bhalani Publishing House.
3. Cohen, H. S., & Sangi-Haghpeykar, H. (2012). Subjective visual vertical in vestibular disorders measured with the bucket test. *Acta Otolaryngologica*, 132(8), 850-854.
4. Desmond, A. L. (2004). Vestibular function: evaluation and treatment. New York: Thieme Medical Publishers Inc.

5. Funabashi, M., Santos-Pontelli, T. E. G., Colafemina, J. F., Pavan, T. Z., Carneiro, A. A. O., & Takayanagui, O. M. (2012). A new method to analyze the subjective visual vertical in patients with bilateral vestibular dysfunction. *Clinics*, 67(10), 1127-1131.
6. Hughes, G. B., & Pensak, M. L. (2007). Clinical Otology. New York: Thieme Publishers Inc.
7. Jackler, R. K., & Brackmann, D. E. (2005). Neurotology. 2nd Ed. Philadelphia, USA: Elsevier Mosby.
8. Jacobson, G. P., & Shepard, N. T. (2008). Balance function assessment and management. San Diego, CA: Plural Publishing Inc.
9. McCaslin, D. L. (2013). Electro-nystagmography and video-nystagmography ENG / VNG. San Diego, CA: Plural Publishing, Inc.
10. Murofushi, T., & Kaga, K. (2009). Vestibular evoked myogenic potential- its basics and clinical applications. Tokyo, Japan: Springer.
11. Shepard, N. T., & Telian, S. A. (1997). Practical management of the balance disorders patient. New York: Thomson Delmar Learning.
12. Vibert, D., Hausler, R., & Safran, A. B. (1999). Subjective visual vertical in peripheral unilateral vestibular diseases. *Journal of Vestibular Research*, 9, 145-152.

**Unit 3: Disorder of the vestibular system**

1. Ackley, R. S., Decker, T. N., & Limb, C. J. (2007). An essential guide to hearing and balance disorders. New Jersey: Lawrence Erlbaum Associates Inc.
2. Biswas, A. (1998). An introduction to neurotology. Mumbai, India: Bhalani Publishing House.
3. Biswas, A. (2009). Clinical audio-vestibulometry for otologists and neurologists. 4th Ed. Mumbai, India: Bhalani Publishing House.
4. Desmond, A. L. (2004). Vestibular function: evaluation and treatment. New York: Thieme Medical Publishers Inc.
5. Furman, J. M., Cass, S. P., & Whitney, S. L. (2010). New York: Oxford University Press Inc.
6. Gaertner, C., Bucci, M. P., Obeid, R., & Wiener-Vacher, S. (2013). Subjective visual vertical and postural performance in healthy children. *PLOS One*, 8(11), e79623, doi:10.1371/journal.pone.0079623.
7. Hughes, G. B., & Pensak, M. L. (2007). Clinical Otology. New York: Thieme Publishers Inc.
8. Jackler, R. K., & Brackmann, D. E. (2005). Neurotology, 2nd Ed. Philadelphia, USA: Elsevier Mosby.
9. Jacobson, G. P., & Shepard, N. T. (2008). Balance function assessment and management. San Diego: Plural Publishing Inc.
10. Kaga, K., & Starr, A. (2009). Neuropathies of the auditory and vestibular eighth cranial nerves. Tokyo, Japan: Springer.
11. Kaga, K. (2014). Vertigo and balance disorders in children. Tokyo, Japan: Springer.
12. Kithara, M. (1990). Meniere's disease. Tokyo, Japan: Springer-Verlag.
13. Kohan, D., Heman-Ackah, S. E., & Chandrasekhar, S. S. (2014). Neurotology- what do I know? New York: Oxford University Press.

**Unit 4: Management of vestibular dysfunction**


1. Arenberg, I. K., & Graham, M. D. (1998). Treatment options for Meniere's disease endolymphatic sac surgery- do it or don't do it. San Diego, CA: Singular Publishing Group Inc.
2. Biswas, A. (1998). An introduction to neurotology. Mumbai, India: Bhalani Publishing House.
3. Desmond, A. L. (2004). Vestibular function: evaluation and treatment. New York: Thieme Medical Publishers, Inc.
4. Furman, J. M., Cass, S. P., & Whitney, S. L. (2010). New York: Oxford University Press Inc.
5. Hughes, G. B., & Pensak, M. L. (2007). Clinical Otology. New York: Thieme Publishers, Inc.
6. Jackler, R. K., & Brackmann, D. E. (2005). Neurotology, 2nd Ed. Philadelphia, USA: Elsevier Mosby.
7. Jacobson, G. P., & Shepard, N. T. (2008). Balance function assessment and management. San Diego, CA: Plural Publishing Inc.
8. Kaga, K. (2014). Vertigo and balance disorders in children. Tokyo, Japan: Springer.
9. Kithara, M. (1990). Meniere's disease. Tokyo, Japan: Springer-Verlag.
10. Shepard, N. T., & Telian, S. A. (1997). Practical management of the balance disorders patient. New York: Thomson Delmar Learning.

**Paper Code: AUD 3.5 b - Auditory Physiology**

**Syllabus as given in I semester (1.4 a)**

**Paper Code: AUD 3.5 c - Technology for Speech-Language & Hearing**

**Syllabus as given in I semester (1.4 b)**

**Paper Code: AUD 3.6 - HC: Clinical Practicum III**

**Paper Code: AUD 3.7 - SC: Dissertation**

## SEMESTER IV

### Paper Code: AUD 4.1 - HC: Assessment and Management of Central Auditory Processing Disorders

**Objectives:**

After completing this subject, the candidate should be able to

1. List the types of CAPD and explain their physiological bases.
2. List the signs and symptoms of CAPD and correlate them with different central auditory processes.
3. List different tests of CAPD and independently design appropriate test protocol for clients with different signs and symptoms.
4. List and explain the factors affecting the assessment.
5. Explain construction and standardization of test of CAPD.
6. Explain management strategies and techniques for improving different central auditory processes.

### Unit 1: Introduction to central auditory processing disorder (CAPD) & screening 18 Hrs

1.1 **Overview to CAPD**

- Critical evaluation of definitions of CAPD
- Processes and cognition involved in CAPD:
    - Binaural integration
    - Binaural separation
    - Temporal processing
    - Auditory closure
    - Binaural interaction
    - Phoneme synthesis
    - Auditory memory and sequencing
    - Sound localization and lateralization

1.2 Neural maturation and auditory processing; Neural degeneration and auditory processing

1.3 Signs and symptoms in individuals with specific central auditory deficits

1.4 Classification of auditory processing disorder; CAPD as a co-morbid disorder

1.5 Screening for CAPD

- Need / utility of screening for CAPD
- Screening questionnaires / check lists for children and adults; Sensitivity and specificity
- Screening tests for children and adults; Sensitivity and specificity
    - Sub-tests of speech / language tests
    - Audiological tests

**Unit 2: Diagnostic assessment of CAPD 18 Hrs**

2.1 Physiological assessment in assessment of CAPD:
- ABR, AMLR, ALLR, MMN, P300 and other potentials
- Contralateral suppression of OAEs

2.2 Behavioural tests in assessment of CAPD/ cognition**:**
- Temporal processing
- Binaural interaction
- Binaural integration
- Auditory separation / closure
- Tests for assessing auditory memory and sequencing
- Assessment of CAPD in subjects with peripheral hearing loss
- Selection of CAPD tests based on signs and symptoms / performance on screening tools

2.3 Factors affecting assessment of CAPD
- Factors related to subject
- Factors related to procedure

2.4 Behavioural and physiological tests:
- Relation between behavioural and physiological tests in different processes

2.5 Performance on tests of CAPD/ order cognition in:
- Children
- Young adults
- Older adults

**Unit 3: Overview to management of CAPD 18 Hrs**

3.1 Direct remediation techniques
- Bottom-up approaches
- Top-down approaches
- Environmental modifications in school set-ups, work place; Compensatory strategies for children and adults

3.2 Devices for subjects with auditory processing disorder; Outcome measures of devices for CAPD

3.3 Phoneme synthesis training; Vigilance training; Auditory memory and sequencing training

3.4 Meta-cognitive and meta-linguistic approaches

3.5 Role of auditory plasticity in management of CAPD

## Unit 4: Techniques and outcome of Process specific management of CAPD 18 Hrs

4.1 Auditory perceptual training for binaural integration and binaural separation
4.2 Auditory perceptual training for temporal processing (temporal ordering, temporal resolution, etc)
4.3 Auditory perceptual training for auditory closure
4.4 Auditory perceptual training for binaural interaction & sound localization and lateralization
4.5 Factors affecting management of CAPDs; Team approach for assessment and management of CAPD

## Practicum:

- For the signs and symptoms of CAPD provided by the faculty, select the appropriate tests and list the possible results with justification.
- Administer any two screening tools on 10 children.
- Administer at least 2 CAPD diagnostic tests on 2 adults, compare with available norms.
- Based on the CAPD test results make recommendations for management.
- Write activities for different meta-cognitive strategies
- Write activities for different meta-linguistic strategies.

## References:

### Unit 1: Introduction to central auditory processing disorders (CAPD) and screening


1. American Speech-Language-Hearing Association. (2005). *(Central) auditory processing disorder (technical report)* Retrieved from http://www.asha.org/ members/desref-journals/deskref/ default.
2. Bellis, T. J. (2003). Assessment and management of central auditory processing disorders in the educational setting: From science to practice. London: Singular Publishing Group Inc.
3. Bhatnagar, S. C., & Andy, O. J. (1995). Neuroscience for the study of communicative disorders. Baltimore: Williams & Wilkins.
4. Chermak, G. D., & Musiek, F. E. (2006). Handbook of (Central) auditory processing disorders- auditory neuroscience and diagnosis. Volume I. San Diego: Singular Publishing Group Inc.
5. Geffnar, D., & Ross-swain, D. (2007). Auditory processing disorders: assessment, management & treatment.
6. Geffner, D., & Ross-Swain, D. (2013). Auditory Processing Disorders: Assessment, management, and treatment. 2nd Edn. San Diego: Plural Publishing Inc.
7. Katz, J. (1994). Handbook of clinical Audiology. (4th Edn), Baltimore: Williams & Wilkins.

8. Keith, R. W. (2000). SCAN-C: Test for auditory processing disorders in children-revised. Antonio, TX: The Psychological Corporation.
9. Musiek, F. E., Baran, J. A., Shinn, J. B., & Jones, R. O. (2012). Disorders of the auditory system. San Diego: Plural Publishing Inc.
10. Parthasarathy, T. K., & Bhatnagar, S. C. (2005). An Introduction to Auditory Processing Disorders in Children. New Jersey: Lawrence Erlbaum Associate.
11. Roser, R. R., Valente, M., & Hosford-Dunn, D (2000). Audiology diagnosis. New York: Thieme Medical Publishers.

**Unit 2: Diagnostic assessment of APD**

1. Baran, J., & Musiek, F. (1999). Behavioral assessment of the central auditory nervous system. In Musiek, F. & Rintelmann, W. (Eds.), Contemporary perspectives in hearing assessment (pp. 375-414). Boston: Allyn and Bacon.
2. Bellis, T. J. (2003). Assessment and management of central auditory processing disorders in the educational setting – from science to practice. London: Singular Publishing Group Inc.
3. Chermak, G. D., & Musiek, F. E. (2006). Handbook of (Central) auditory processing disorders- auditory neuro-science and diagnosis. Vol. I. San Diego: Singular Publishing Group Inc.
4. Geffner, D., & Ross-Swain, D. (2013). Auditory Processing Disorders: Assessment, management, and treatment. 2nd Edn. San Diego: Plural Publishing, Inc.
5. Jerger, J., Thibodeau, L., Martin, J., Mehta, J., Tillman, G., & Greenwald, R., et al. (2002). Behavioral and electrophysiologic evidence of auditory processing disorder: A twin study. *Journal of the American Academy of Audiology*, 13, 438-460.
6. Katz, J. (1994). Handbook of clinical Audiology. (4th Edn), Baltimore: Williams & Wilkins.
7. Katz J., Chasin M., & English, K. (2014). Handbook of clinical audiology, 7th Edn. Philadelphia: Lippincott Williams & Wilkins.
8. Keith, R. W. (1981). Central auditory and language disorders in children. Houston: College-Hill Press.
9. Musiek, F. E., & Chermak, G. D. (2014). Handbook of Central Auditory Processing Disorder: Auditory neuroscience and diagnosis. 2nd Edn, Vol: 1. San Diego: Plural Publishing Group Inc.
10. Parthasarathy, T. K., & Bhatnagar, S. C. (2005). An Introduction to Auditory Processing Disorders in Children. New Jersey: Lawrence Erlbaum Associate.
11. Pinheiro, M. L., & Musiek, F. E. (1985). Assessment of central auditory dys-function: foundations and clinical correlates. Baltimore: Williams & Wilkins.
12. Roser, R. R., Valente, M. & Hosford-Dunn, D (2000). Audiology diagnosis. New York: Thieme Medical Publishers.

**Unit 3: Overview to management of CAPD**

1. American Speech-Language-Hearing Association. (2005). (Central) auditory processing disorder (technical report) Retrieved from http://www.asha.org/ members/desref-journals/deskref/ default.

2. Bellis, T. J. (2003). Assessment and management of central auditory processing disorders in the educational setting – from science to practice. London: Singular Publishing Group Inc.
3. Bellis, T. J. (2002). Developing deficit-specific intervention plans for individuals with auditory processing disorders. *Seminar in Hearing*, 23(4), 287-297.
4. Chermak, G. D. (1998). Managing central auditory processing disorders: Meta-linguistic and meta-cognitive approaches. *Seminars in Hearing*, 19(4), 379-392.
5. Chermak, G. D., & Musiek, F. E. (2006). Handbook of (Central) auditory processing disorders – comprehensive Intervention. Vol. II. San Diego: Singular Publishing Group Inc.
6. Chermak, G. D., & Musiek, F. E. (2002). Auditory training: Principles and approaches for remediating and managing auditory processing disorders. *Seminars in Hearing*, 23(4), 297-308.
7. Friel-Patti, S. (1999). Treatment for central auditory processing disorders: clinical decision making in the assessment and intervention of CAPD. Languages, Speech and Hearing Services in Schools, 30, 345-352.
8. Geffner, D., & Ross-Swain, D. (2013). Auditory Processing Disorders: Assessment, management, and treatment. 2nd Edn. San Diego: Plural Publishing Inc.
9. Johnson, C. D., Benson, P. V., & Seaton, J. B. (1997). Educational audiology handbook. San Diego: Singular Publishing Group.
10. Katz, J., Stecker, N. A., & Handerson, D. (1992). Central auditory processing: A transdisciplinary view. St. Louis: Mosby.
11. Keith, R. W. (1981). Central auditory and language disorders in children. Houston: College-Hill Press.
12. Master, M. G., Stecker, N. A., & Katz, J. (1998). Central auditory processing disorders: mostly management. Boston: Allyn & Bacon.
13. Musiek, F. E. (1999). Habituation and management of auditory processing disorders: overview of selected procedures. Journal of American Academy of Audiology. 10, 329-342.
14. Willeford, J. A., & Burleigh, J. M. (1985). Handbook of CAPD in Children. Orlando: Grune & Stratton Inc.

**Unit 4: Techniques and outcome of process specific management of CAPD**

1. Bellis, T. J. (2003). Assessment and management of central auditory processing disorders in the educational setting – from science to practice. London: Singular Publishing Group Inc.
2. Bellis, T. J. (2002). Developing deficit-specific intervention plans for individuals with auditory processing disorders. Seminar in Hearing, 23(4), 287-297.
3. Chermak, G. D., & Musiek, F. E. (2006). Handbook of (Central) auditory processing disorders – comprehensive Intervention. Volume II. San Diego: Singular Publishing Group Inc.
4. Friel-Patti, S. (1999). Treatment for central auditory processing disorders: clinical decision making in the assessment and intervention of CAPD. Languages, Speech and Hearing Services in Schools, 30, 345-352.

5. Geffner, D., & Ross-Swain, D. (2013). Auditory Processing Disorders: Assessment, management, and treatment. 2nd Edn. San Diego: Plural Publishing Inc.
6. Master, M. G., Stecker, N. A., & Katz, J. (1998). Central auditory processing disorders: mostly management. Boston: Allyn & Bacon.
7. Musiek, J. F., Baran, J. A. & Pinheiro, M. L. (1994). Neuro-audiology: Case studies. San Diego: Singular Publishing Group.
8. Musiek, F. E., Shinn, J., & Hare, C. (2002). Plasticity, auditory training, and auditory processing disorders. Seminars in Hearing, 23, 273-275.
9. Roser, R. R., Valente, M. & Hosford-Dunn, D (2000). Audiology diagnosis. New York: Thieme Medical Publishers.
10. Willeford, J. A & Burleigh, J. M. (1985). Handbook of CAPD in Children. Orlando: Grune & Stratton Inc.

## Paper Code: AUD 4.2 - HC: Audiology in Practice

**Objectives:**

After studying this course, student should be able to

1. Know the role of an Audiologist in different set-ups.
2. Liaison with other professionals in setting-up an audiological clinic.
3. Audit the practices in existing set-ups.
4. Implement acts and legislations concerned with hearing disability.
5. Know the role of Audiologist in legal matters.

### Unit 1: Audiology practice in different set-ups 18 Hrs

1.1 Scope, challenges and solutions of audiological practices in
- Rural/tribal areas
- Medical setup
- Industrial setup
- School setup
- Private practice

1.2 Tele-practice in Audiology
- Concept of tele-practice
- Need for tele-practice
- Method, infrastructure and human resource requirement
- Advantages and limitations of tele-practice

1.3 Allied professionals to be involved and their scope in screening / diagnostic work in
- Rural/tribal areas
- Paediatric set-up
- Neurological set-up
- Otolaryngological set-up
- Industrial set-up
- School set-up

1.4 Marketing, business, fundraising in Audiological practice
- Need
- Strategies
- Ways to overcome problems

### Unit 2: Construction and development of audiology set-ups 18 Hrs

2.1 Designing acoustically treated rooms:
- Transmission loss
- Reverberation control
- Illumination
- Electrical connections-electrical shielding, grounding and connecting jacks
- Professionals involved in designing/construction audiological test facility

2.2 Differences in the infrastructure (equipment, space, room design, financing) requirements for
- Rural/tribal areas
- Paediatric set-up
- Neurologocal set-up
- Otolaryngological set-up
- Industrial set-up
- School set-up
- Private practice
- Audiology practice in medical collages and hospitals

2.3 Setting up of a speech and hearing college

2.3 Auditing Processes in different set-ups
- Method to audit
- Goals to be achieved
- Measures to be taken to prevent malpractice by allied professionals

**Unit 3: Welfare measures for individuals with hearing-impairment 18 Hrs**

3.1 Scope of different Government departments/ non-Government organizations in prevention, identification, rehabilitation and follow-up of individuals with hearing impairment:
- Health & Family Welfare
- Women & Child Development
- Social Justice & Empowerment
- Education Department
- Human Resource Department
- Others Government Departments
- Non-Government Organization

3.2 Facilities available for the individuals with hearing impairment in India
- Comparison with other disabilities

3.3 Role of the audiologist as a policy maker
- In committees dealing with disability issues (Eg. RCI, PWD Act)
- In committees dealing with hearing devices (Eg. BIS, ADIP scheme)

**Unit 4 : Law and audiology 18 Hrs**

4.1. Ethics in practice (in India and in other countries)

4.2. Medico-legal aspects in Audiology
- Forensic Audiology
- Audiologist as an expert witness
- Report writing

4.3 Auditing of implementation of Acts and Legislations:
- PWD act, RCI act, FDA, UNCRPD, NPPCD, Sarvasiksha Abhiyan
- Biwako Millinenium Framework, Salamanca statement and framework
- Insurance Against Malpractice, Consumer Protection Act, Evidence Act

**Practicum:**

1. To explain various legislations and National Acts such as - PWD Act, RCI Act, FDA, UNCRPD, NPPCD, Sarvasiksha Abhiyan.
2. To explain Biwako Millinenium Framework, Salamanca statement and framework.
3. To explain various welfare measures for the individuals with hearing impairment in India regarding travel, education, vocation, others, comparison with other disabilitie.
   i. RCI, PWD Act
   ii. BIS, ADIP scheme
4. To prepare a project proposal for developing an audiology clinic in one of the following set-ups
   i. Rural/tribal areas
   ii. Paediatric set-up
   iii. Neurological set-up
   iv. Otolaryngological set-up
   v. Industrial set-up
   vi. School set-up
   vii. Make an indent for procurement of an audiological equipment.

**Reference:**

**Unit 1: Audiology practice in different set-ups**

1. Dunn, H.H., Roeser, R.J., & Valente, M. (2000). Audiology- practice management. New York: Thieme Medical Publishers Inc.
2. Dunn, H.H., Dunn, D.R., & Harford, E.R. (1995). Audiology business & practice management. San Diego: Singular Publishing Group Inc.
3. Taylor, B. (2015). Marketing in an Audiology practice. San Diego: CA: Plural Publishing Inc.
1. College of Audiologists and Speech-Language Pathologists of Ontario. (2004). Use of Telepractice Approaches in Providing Services to Patients/Clients.
2. Vijayalakshmi et al. (2013). Audiological Practice in India: An Internet-Based Survey of Audiologists. Indian J Otolaryngol Head Neck Surg. 65, 636–644.

**Unit 2: Construction and development of audiology set-ups**

1. Acoustic systems. (1984). Brochure on audiometric testing booths.
2. Agnon, R., Bartenwerfer, M., Gikadi, T., & Neisew, W. (1976). Noise reduction methods in centrifugal fans. In R.X. Kerlin (Ed.). Inter-Noise 76 proceedings. (pp. 43-46). New York: Institute of Noise Control Engineering.
3. ANSI S3.1 (1991). Cited in Wilber, L.A. (1994). Calibration, Puretones, Speech and Noise signals. In J. Katz (Ed.). Handbook of Clinical Audiology (pp. 73-79). Baltimore: Williams & Wilkins.

1. Dunn, H.H., Roeser, R.J., & Valente, M. (2000). Audiology- practice management. New York: Thieme Medical Publishers Inc.
2. Dunn, H.H., Dunn, D.R., & Harford, E.R. (1995). Audiology business & practice management. San Diego: Singular Publishing Group Inc.
3. Taylor, B. (2013). Strategy and Design in Your Audiology Clinic. *Retrived from* http://www.audiologyonline.com/articles/strategy-and-design-in-your-11967
4. Resource Guide for Educational/Pediatric Audiologists. *Retrieved from* http://www.asha.org/aud/pediatric-ed

**Unit 3: Welfare measures for individuals with hearing-impairment**

1. Trivedi, P.R., & Gurdeep, R. (1992). Noise pollution. New Delhi: Akashdeep Publishing House.
2. King, P.F. et al., (1993). Assessment of hearing disability- guidelines for medico-legal practice, London: Whurr Publishers.
3. Rizzo, S.R., & Trudean, M.D. (1994). Clinical administration in audiology and speech language pathology. San Diego: Singular Publishing Group Inc.
4. Stephen, R.R., Jr., & Trudeau, D.M. (Eds.) (1994). Clinical administration in audiology & speech language pathology. San Diego: Singular Publishing Group Inc.
5. Cochlear Implant under ADIP Scheme of Government of India. *Retrieved from* http://adipcochlearimplant.in/.
6. The rights of persons with disabilities act (2014). Retrieved from http://rpwd.in/Downloads/Default.aspx

Various Indian and international legislations.

**Unit 4: Law and audiology**

1. Trivedi, P.R., & Gurdeep, R. (1992). Noise pollution. New Delhi: Akashdeep Publishing House.
2. King, P.F. et al., (1993). Assessment of hearing disability- guidelines for medico-legal practice, London: Whurr Publishers.
3. Rizzo, S.R., & Trudean, M.D. (1994). Clinical administration in audiology and speech language pathology. San Diego: Singular Publishing Group Inc.
4. Stephen, R.R., Jr., Trudeau, D.M. (Eds.) (1994). Clinical administration in audiology & speech language pathology. San Diego: Singular Publishing Group Inc.

Various Indian and international legislations.

## Paper Code: AUD 4.3 - HC: Speech Perception in Clinical Population

**Objectives:**

After completing this course, the candidate should be able to

1. Explain about speech perception in individuals with different configurations, types, degrees of hearing impairment
2. Differentiate / compare perception of speech through different senses and listening devices
3. Critically examine different methods to evaluate speech intelligibility, and describe the factors effecting speech intelligibility
4. Apply information on speech intelligibility / speech perception in the field of speech and hearing

**Unit 1: Perception of vowels and consonants in individuals with hearing impairment 18 Hrs**

1.1 Perception of vowels, semivowels, and diphthongs in individuals with hearing impairment.

1.2 Perception of consonants in individuals with a hearing impairment.

1.3 Effect of type, degree and audiogram configuration in perception of vowels and consonants.

**Unit 2: Perception of coarticulation and suprasegmental 18 Hrs**

2.1 Perception of coarticulation in individuals with hearing impairment.

- Perception of vowels from adjacent consonantal segmental cues.
- Perception of consonants from adjacent vowel segmental cues.
- Perception of vowels from adjacent vowel segmental cues.
- Perception of consonants from adjacent consonant segmental cues
- Influence of direction of coarticulation on perception.

2.2 Perception of suprasegmental cues in individuals with hearing impairment:

- Perception of stress,
- Perception of rhythm
- Perception of intonation

2.3 Perception of speech through the visual modality

- Perception of segmental and suprasegmental cues

2.4 Perception of speech through the tactile modality

- Perception of segmental and suprasegmental cues

2.5 Audio-visual integration of speech in individuals with SN hearing loss

**Unit 3: Speech perception through different devices 18 Hrs**

3.1 Perception of speech through cochlea implants

- Overview of speech perception through single channel implants:
  - Vowels perception
  - Consonants perception
  - Speech identification scores
  - Suprasegmental cues

3.2 Perception through multi-channel cochlear implants

- Vowels perception
- Consonants perception
- Speech identification scores
- Suprasegmental cues

3.3 Effect of the following on speech perception

- Coding strategy
- Threshold, comfort levels and Dynamic range
- Frequency allocation of electrodes
- Number of channels and maximas
- Stimulation rate and pulse width
- Pre-processing strategies and other noise reduction procedures

3.4 Speech perception through implanted hearing aids, middle ear implants, auditory brain-stem implants and mid-brain implants

3.5 Perception of speech through digital hearing aids

- Influence of out-put limiting circuits on perception for different degrees of hearing loss and audiogram configuration
- Influence of number of channels on perception for different degrees of hearing loss and audiogram configuration

**Unit 4: Speech intelligibility and listening in adverse listening conditions 18 Hrs**

4.1 Speech intelligibility

- Subjective procedures
  - Perceptual tests to evaluate perceptual deviance
  - Perceptual procedures to evaluate production deviance
- Objective procedures
  - Articulation index and its modifications
  - Speech transmission index
- Comparison of subjective and objective procedures
- Factors influencing speech intelligibility
  - Stimulus based factors
  - Subject based factors
  - Transmission based factors

4.2 Speech perception in adverse listening conditions

- Effect of noise on speech perception in normal and the hearing impaired
    - Effect of different types of noise
    - Effect of different signal-to-noise ratios
    - Effect on different age groups
    - Effect on different degrees of hearing-impairment
- Effect of reverberation on speech perception
    - Effect of different reverberation times
    - Effect on age different age groups
    - Effect on different degrees of hearing-impairment
- Combined effect of noise and reverberation on speech perception
- Effect of nonnative accent on speech perception

4.3 Application of speech perception in:
- Evaluation of the hearing impaired
- Rehabilitation of the hearing impaired
- Research regarding the hearing- impaired.

**Practicum:**

1. Evaluate the importance of burst and transition on perception of stops in 5 individuals with simulated conductive hearing loss
2. Evaluate the importance of burst and transition on perception of stops in 5 individuals with simulated SN hearing loss with different cutoff frequencies
3. Measure the effect of number of channels, frequency band on speech perception in cochlear implant simulated speech on normal hearing adults
4. Measure speech perception for CV syllables and words in various SNR and reverberation times
5. Calculate audibility index for 5 different degree and 5 different configuration of hearing loss with and without correction factors

**Reference:**

**Unit 1: Perception of vowels and consonants in individuals with hearing impairment**

1. Dubno, J. R., Dirks, D. D., & Schaefer, A. B. (1987). Effects of hearing loss on utilization of short-duration spectral cues in stop consonant recognition. *Journal of Acoustic Society of America,* 81(6):1940-7.
2. Fant, G. (1972). International symposium on speech communication ability and profound deafness. Washington: Alexander Graham Bell Association for the Deaf.
3. Pickett, J.M., & Ravolie, S.G. (1979). Feature discrimination by persons with sensori-neural hearing impairment. In B. Lindblom and S. Ohman (Eds.), Frontiers of speech communication research. London: Academic Press.
4. Pickett, J.M., & Danaher, E.M. (1975). On discrimination for formant transitions by persons with severe sensori-neural hearing loss. In G.Fant and M.A. Tatham (Eds.), Auditory analysis and perception of speech. New York: Academic Press.

5. Revoile, Holden-Pitt & Pickett (1984). Perceptual cues to the word- vowel distinction of final fricative for listeners with impaired or with normal hearing. *Journal of American Academy of Audiology*, 77(3), 1263-1265.
6. Revoile, Holden-Pitt, Pickett & Bandt (1986). Speech enhancement for the hearing impaired: altered vowel duration for perception of final "F" voicing. *Journal of Speech and Hearing Research*, 29,240-255.
7. Revoile, Pickett & Kozma-Spytek (1991). Spectral cues to perception of /d,n,l/ by normal and impaired-hearing listeners. *Journal of American Academy of Audiology*, 90(2), 787-798.
8. Revoile, Pickett, Talkin & Brendt (1987). Burst and transition cues to voicing perception for spoken initial stops by impaired and normal hearing listeners. *Journal of Speech and Hearing Research*, 30, 3-12.
9. Revoile, S. G., Holden-Pitt, L., Pickett, J. M. (1985). Perceptual cues to the voiced-voiceless distinction of final fricatives for listeners with impaired or with normal hearing. *Journal of Acoustic Society of America,* 77(3):1263-5.
10. Revoile, S.G., & Pickett, J.M. (1982). Speech perception by the severely hearing-impaired. In D.G.Sims, D.G. Walter and R.L. Whitenead (Eds.), Deafness and Communication. Baltimore: Williams & Wilkins.
11. Liu, C., & Kewley-Port, D. (2007). Factors affecting vowel formant discrimination by hearing-impaired listeners. *The Journal of the Acoustical Society of America*, *122*(5), 2855–64. http://doi.org/10.1121/1.2781580
12. Alexander, J. M., & Kluender, K. R. (2009). Spectral tilt change in stop consonant perception by listeners with hearing impairment. *Journal of Speech, Language, and Hearing Research*, *52*(3), 653–70. http://doi.org/10.1044/1092-4388(2008/08-0038)

**Unit 2: Perception of co-articulation and suprasegmental**

1. Carney, A. E., Kienle, M., Miyamoto, R. T. (1990). Speech perception with a single-channel cochlear implant: a comparison with a single-channel tactile device. *Journal of Speech and Hearing Research,* 33(2):229-37.
2. DeFilippo, C.L. (1982). Tactile perception. In D.G. Sims, G.C.Water and R.L.Whiteherd (Eds.) Deafness and Communication. Baltimore: Williams & Wilkins.
3. Green berg. H.J., & Bode. D.L. (1968). Visual discrimination of consonants. *Journal of Speech and Hearing Research,* 11, 869-874.
4. Montgomery, A., & Walden.B.E. (1987). Effects of consonantal context on vowel lip reading. *Journal of Speech and Hearing Research*, 30, 50-59.
5. Owens, E. (1985). Visimes observed by hearing impaired and normal hearing adult viewers. *Journal of Speech and Hearing Research*, 28, 381-393.
6. Plant, G. L. (1982). Tactile perception by the profoundly deaf. Speech and environmental sounds. *British Journal of Audiology*, 16(4):233-44.
7. Summerfield, A.Q. (1983). Audio-visual speech perception, lip reading and artificial stimulation. In M.E.Lutman and M.P.Haggard (Eds.), Hearing science and hearing disorders. London: Academic Press.

**Unit 3: Speech perception through different devices**


1. Bosco, et al. (2004). Comparison between the speech perception skills in children with cochlear implants using different strategies such as CIS, SAS and Hi-Resolution. *Acta Otolaryngologica*, 125, 148-158.
2. Carney, A. E., Osberger, M. J., Carney, E., Robbins, A. M., Renshaw, J., & Miyamoto, R. T. (1993). A comparison of speech discrimination with cochlear implants and tactile aids. *Journal of the Acoustic Society of America.* 94(4), 2036-49.
3. Clark, G. (2003). Cochlear Implants: fundamentals & application. New York: Springer-Verlag Inc.
4. Friszt, et al. (2004). Recognition of speech presented at soft to loud levels by adults cochlear implant recipients of three cochlear implant systems. *Ear and Hearing*, 25, 375-387.
5. Gfeller, K., Woodworth, G., Robin, D.A., Witt, S., & Knutson, J.F. (1997). Perception of rhythmic and sequential pitch patterns by normally hearing adults and adult cochlear implant users. *Ear and Hearing*, 18, 252-260.
6. Lendra, M., Friesen., Robert. V. Shannon., & Rachel. J. Cruz. (2005). Effects of stimulation rate on speech recognition with cochlear implants. *Audiology and Neurotology*, 10, 169-184.
7. Loizou, P., & Poroy, O. (2001). Minimum spectral contrast needed for vowel identification by normal hearing and cochlear implant listeners. *Journal of Acoustic Society of America*, 110(3), 1619-1627.
8. Miyanoto, et al. (1995). Comparison of multi channel tactile aids and multi channel cochlear implants in children with profound hearing impairments. *American Journal of Otolaryngology*, 16(1), 8-13.
9. Osberger, et al. (1990). Performance of deaf children with cochlear implants and vibro-tactile aids. *Journal of American Academy of Audiology*, 1(1), 7-10.
10. Spahr, Michael & Dorman (2004). Performance of subjects with the Advance Bionics CII and Nucleus 3G cochlear implant devices.


**Unit 4: Speech intelligibility and listening in adverse listening conditions**


1. Beattie, R.C., Barr, T., & Roup, C. (1977). Normal and hearing impaired word recognition scores monosyllabic words in quiet and noise. *British Journal of audiology*, 153-164.
2. Beutelmann, R., & Brand, T. (2006). Prediction of speech intelligibility in spatial noise and reverberation for normal-hearing and hearing-impaired listeners. *Journal of the Acoustic Society of America,* 120(1):331-42.
3. Bradow, A.R., & Bent, T. (2002). The clear speech affect for non-native listeners. *Journal of acoustical society of America.* 112(1), 272-284.
4. Cox, R.M., & McDaniel, D.M. (1989). Development of speech intelligibility rating test for hearing aid comparisons. *Journal of speech and hearing research*, 32, 347-352.
5. Flanagan, J.L. (1972). Speech analysis synthesis and perception. New York: Springer-Verlag.
6. Hosnsby, B.W.Y. (2004). The speech intelligibility index, what is it and what's it good for? *The Hearing Journal,* 58 (10), 10-17.

7. Kryter, K.D. (1962). Validation of the articulation index. *Journal of acoustical society of America* 34, 1968-1702.
8. Pavlov, C.V. (1987). Derivation of primary parameters and procedures for use in speech intelligibility prediction. *Journal of acoustical society of America*. 82, 413-422.
9. Pavlov, C.V. (1991). Speech recognition and five articulation index. *Hearing instruments*, 42(9), 20-23.
10. Pavlovic & Studebaker (1986). An articulation index based procedure for predicting the speech recognition performance of hearing impaired individuals. *Journal of acoustical society of America*. 80(1), 50-56.
11. Poissant, S. F., Whitmal, N. A., & Freyman, R. L. (2006). Effects of reverberation and masking on speech intelligibility in cochlear implant simulations. *Journal of the Acoustic Society of America,* 119(3):1606-15.
12. Sherbecoe, R.L., & Studebaker, G.A. (2003). Audibility-index predictions of normal hearing and hearing impaired listener's performance on the connected speech test. *Ear and hearing*, 24, 71-88.
13. Wagener, K.C., & Brand, T. (2005). Sentences intelligibility in noise for listeners with normal hearing and hearing impairment: influence of measurement procedure and masking parameters. *International Journal of Audiology*. 44 (3), 144-156.
14. Zelnick, E. (1991). The use of articulation index simplified: Part I, *Audicibel,* 49, 32-37.
15. Zelnick, E. (1992). The use of articulation index simplified. Part II, *Audicibel*, 50, 22-26.
16. Phatak, S. A., Yoon, Y.-S., Gooler, D. M., & Allen, J. B. (2009). Consonant recognition loss in hearing impaired listeners. *The Journal of the Acoustical Society of America*, *126*(5), 2683–94. http://doi.org/10.1121/1.3238257

**Paper Code: AUD 4.4 - HC: Clinical Practicum IV**

**Paper Code: AUD 4.5 - SC: Dissertation**

## Paper Code: AUD 2.5 - OE: Signal Processing Strategies and Their Implementation in Hearing Aids

**Objectives:**

a) To give an overview of the latest technology of hearing aids
b) To provide fundamental concepts of digital signal processing.
c) To learn the various signal processing strategies used in hearing aids
d) To understand and observe the effects of signal processing strategies.
e) To learn the procedures for electroacoustic evaluation of hearing aids.
f) To learn how to setup and use the equipment for measurement of spectral and temporal characteristics analysis of hearing aid output.

**Unit 1: Introduction to hearing aid components 12 Hrs**

1.1 Hearing aid components
- Microphones: Basic structure & principle of operation of electret microphones, single port and dual port microphones and microphones in body worn, BTE & ITC hearing aids, microphone sensitivity
- Telecoil: Basic structure, principle of operation & frequency response of active and passive telecoil
- Receivers: Basic structure & principle of operation of moving coil and balanced armature type receivers.

1.2 Hearing aid controls and their variations
- Volume control
- OTM switch
- Battery door switch
- Output control
- Other trimmer controls

1.3 Hearing aid accessories
- Battery: Various types and their characteristics
- Chords: Various types
- Ear hooks: Types and frequency shaping
- Connecting tube: Types and frequency shaping

**Unit 2:Introduction to digital signal processing 12 Hrs**

2.1 Digital signal processing
- Basic structure of a Digital signal processing system
- Process of Analog to Digital conversion
- Process of Digital to Analog conversion
- Basic concepts of Digital Signal Processing - Decomposition, Processing and Synthesis

2.2 Implementation of *Signal processing functions* using DSP

- Amplifiers
- Filters
- Types of digital filters
- Basic architecture of a fully digital Hearing Aid

2.3 Advantages of DSP in hearing aid signal processing

- Major characteristics of DSP
- Advantages of DSP analog processing
- Features in hearing aids due to DSP

**Unit 3: Signal processing in hearing aids 15 Hrs**

3.1 Nonlinear amplification

- Basic technology - Input compression, output compression
- Dynamic characteristics
- BILL & TILL
- Channel Separation

3.2 WDRC & Output limiting

- Signal processing techniques for Implementation of WDRC
- Negative effects of DSP based WDRC
- Signal processing techniques for output Limiting

3.3 Noise reduction & feedback cancellation

- Signal processing techniques for noise reduction
- Noise reduction through microphone technology

**Unit 4: Objective studies on hearing aids 15 Hrs**

4.1 Electroacoustic parameters

- Procedure of electroacoustic evaluation defined by International Standards
- National standards and the difference in procedures
- ISTS Stimuli
- Equipment setup for electroacoustic evaluation

4.2 Objective studies of temporal behaviour

- Equipment setup
- Techniques for measurement
- Techniques for analysis

4.3 Objective studies of spectral behaviour

- Equipment setup
- Techniques for measurement
- Techniques for analysis

**Practicum:**

a) Basic structure of transducers.
b) Measuring electroacoustic parameters
c) Objective studies of temporal behavior
d) Objective studies of spectral behavior

**References:**

**Unit 1: Introduction to hearing aid components**

1. Crocker, M.J. (1998). *Handbook of Acoustics,* New York: John Wiley & Sons, Inc.,
2. Rossing, T.D. (2002). *The Science of Sound 3rd Edn.,* Glenview: Pearson Education, Inc.,
3. Vonlanthen, A. (2007). *Hearing Instrument Technology for the Hearing Health Care Professionals*. London: Singular Publishing Group
4. Dillon, Harvey (2001). *Hearing Aids*. New York: Thieme Medical Publications.

**Unit 2: Introduction to digital signal processing**

1. Schaub, Arthur. (2008). *Digital Hearing Aids.* New York: Thieme Medical Publishers, Inc.
2. Malvino, A. P. (1979). *Digital Computer Electronics.* Bombay: Tata McGraw Hill
3. Tan, Li Jiang. (2013). *Digital Signal Processing: Fundamentals and Applications 2nd Ed.* New York: Academic Press Inc

**Unit 3: Signal processing in hearing aids**

1. Schaub, Arthur. (2008). *Digital Hearing Aids.* New York: Thieme Medical Publishers, Inc.
2. Vonlanthen, A. (2007). *Hearing Instrument Technology for the Hearing Health Care Professionals*. London: Singular Publishing Group
3. Valente, Michael. (2002). *Hearing Aids: Standards, Options and Limitations*: New York: Thieme Medical Publishers.
4. Sandlin, R.E. (2002). *Handbook of Hearing Aid Amplification, Volume I: Theoretical and Technical Considerations,* London : Singular Publishing Group, Inc.

**Unit 4: Objective studies on hearing aids**

1. Vonlanthen, A. (2007). *Hearing Instrument Technology for the Hearing Health Care Professionals*. London: Singular Publishing Group
2. Valente, Michael. (2002). *Hearing Aids: Standards, Options and Limitations*: New York: Thieme Medical Publishers.
3. Sandlin, R.E. (2002). *Handbook of Hearing Aid Amplification, Volume I: Theoretical and Technical Considerations,* London : Singular Publishing Group, Inc.

## Paper Code: AUD 2.5 - OE: Prevention and Screening of Hearing Impairment

**Objectives:**

After studying this course, the students are expected to appreciate the:

1. Importance of prevention and early identification of hearing impairment
2. Ways to prevent hearing impairment
3. Ways to screen hearing impairment at early stage
4. Need for early rehabilitation
5. Need for counselling and making appropriate referrals

**Unit 1: Hearing and hearing loss 18 Hrs**

1.1 Physical attributes of sound
1.2 Overview of the ear, its function
1.3 Role of hearing, impact of hearing loss, classification of hearing impairment
1.4 Causes of hearing loss
1.5 Signs and symptoms of hearing impairment
1.6 Development of human auditory behavior

**Unit 2: Prevention and early identification of hearing impairment 18 Hrs**

2.1 Need for prevention and early identification of hearing impairment
2.2 Different levels of prevention – primary, secondary and tertiary
2.3 Critical age concept and sensitivity period for language acquisition
2.4 Requirements of a good screening tool
2.5 Subjective test procedures and interpretation (Case history, check lists, behavioural observation)

**Unit 3: Screening for hearing impairment 18 Hrs**

3.1 Objective screening tests procedure (OAE and ABR)
3.2 Individual and group screening / Role of mass media in screening
3.3 Interpretation of screening results and appropriate referrals
3.4 Sensitivity and specificity of different screening tools
3.5 Strategies to ensure follow-up of referred clients

**Unit 4: Early intervention of hearing impairment 18 Hrs**

4.1 Need for early intervention
4.2 Counselling and referral for therapeutic management
4.3 Team members and their role
4.4 Overview to management techniques (hearing devices, modes of communication and modes of education)

**Practicum:**

1. Prepare a chart on development of auditory behaviour.
2. Administration of hrr on caregivers or significant others of at least 2 children.
3. Administer hearing screening tests and use of noise makers in at least 3 children.
4. Observation of hearing evaluation and hearing aid trial of children and adults (1 each).
5. Observation of auditory training (2 sessions).
6. Maintenance of record of the above.

**Reference:**

**Unit 1: Hearing and hearing loss**

1. Newby, H.A. (1985), Audiology, Ed. 5. Englewood Cliffs, N.J: Prentice Hall.
2. Hayes, D., & Northern, J. L. (1996). Infants and hearing. San Diego: Singular Publishing Group Inc.

**Unit 2: Prevention and early identification of hearing impairment**

1. Hayes, D., & Northern, J. L. (1996). Infants and hearing. San Diego: Singular Publishing Group Inc.
2. Rajeev, J., Aparna, N., & Anuradha, B. (2006). Introduction to hearing impairment. DSE (HI) Manual.

**Unit 3: Screening for hearing impairment**

1. Newby, H.A. (1985), Audiology, Ed. 5. Englewood Cliffs, N.J: Prentice Hall.
2. Hayes, D., & Northern, J. L. (1996). Infants and hearing. San Diego: Singular Publishing Group Inc.

**Unit 4: Early intervention of hearing impairment**

1. Hayes, D., & Northern, J. L. (1996). Infants and hearing. San Diego: Singular Publishing Group Inc.
2. Erber, N.P. (1982), Auditory Training, Washington: A.G. Bell Association for deaf.