

**KERALA UNIVERSITY OF HEALTH SCIENCES**

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**REGULATIONS, CURRICULUM, AND SYLLABUS OF**

**MASTER OF SCIENCE  
(AUDIOLOGY) - M.Sc. (Aud)**

*(With effect from 2019-20 admission onwards)*

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# **1. INTRODUCTION**

## **1.1 Preamble**

The regulation of the Master of Science (Audiology) M.Sc. (Aud) shall be the short form; being conducted by the Kerala University of Health Sciences is in accordance with the recommendations of the respective council with an emphasis on the health needs of the Kerala State.

## **1.2 Title of the course**

It shall be Master of Science (Audiology). Abbreviated as M.Sc. (Aud)

### *1.2.1 Definition of Specialty*

**Audiology-** Is defined as the science of hearing and balancing, art of its assessment and the habilitation and rehabilitation of individuals with hearing and balancing disorders.

# **2. AIMS AND OBJECTIVES OF COURSES**

## **2.1 Goals of the course**

The objectives of the M.Sc. (Aud) program are to equip the students with knowledge and skills to

- Function as teachers and researchers in institutions of higher learning,
- Diagnose and manage disorders of hearing and balance across life span,
- Counsel and guide persons with disorders of hearing and balance as well as their family members,
- Implement rehabilitation programs for persons with hearing and balance disorders,
- To function as the disability certification authority in the field,
- Liaise with professionals in allied fields and other stake holders,
- Implement prevention and public education programs,
- Undertake advocacy measures on behalf of and for persons with hearing and balance disorders,

- Advise government and other institutions on legal and policy issues related to persons with hearing and balance disorders, and
- To establish and administer institutions of higher learning in the area.

### **3. REGULATIONS**

#### **3.1 Academic eligibility for admission**

*3.1.1* Candidates with a BASLP or B.Sc (Speech & Hearing) degree of any University recognized by the Rehabilitation Council of India and RCI and approved by Kerala University of Health Sciences. An average of not less than 55% of marks are eligible for admission to M.Sc. (Aud). "Average" refers to average of the aggregate marks obtained in all the years/semesters of the qualifying examination.

*3.1.2* Relaxation in the qualifying marks for designated categories of students shall be as per rules and regulations of respective University / State / Union Territories or the Central Government.

*3.1.3* Applicants shall not be older than 30 years at the time of admission.

*3.1.4* The selection of students for the M.Sc.(Aud) course shall be made based strictly on merit as decided by the competent authority approved by the Government of Kerala/Kerala University of Health Sciences and as per guidelines of the respective council.

#### **3.2 Registration**

A candidate on admission to the M.Sc. (Aud) course shall apply to the University for Registration

- By making a formal application in the prescribed format.
- Original degree certificate/mark lists of qualifying examination.
- Transfer certificate from the previous institution.

- Allotment letter from the competent authority who conducted the admission.
- Equivalency and migration certificate wherever needed.
- Original SSLC/equivalent certificate.
- Internship certificate.
- The fees prescribed for the registration.

### **3.3 Duration of the program**

3.3.1 The program shall be of 4 semesters (2 academic years) and should be completed within 4 years from the date of admission.

3.3.2 An academic year consists of two semesters, and each semester shall extend over a minimum period of sixteen weeks excluding examination days. The semesters shall be spread out as follows:

Odd semesters – 1 & 3

Even semesters – 2 & 4

3.3.3 There shall be examination at the end of each semester.

### **3.4 Medium of instruction and examination**

Medium of instruction shall be English.

### **3.5 Student Teacher Ratio**

Student-Guide ratio: 3:1.

One teacher can take a maximum of 3 students in each academic year.

### **3.6 Examination**

*3.6.1 Eligibility for appearing for the University examination*

#### **a. Attendance, conduct and condonation option:**

Each candidate should put in at least 80% of attendance in Theory class & 90% attendance in Clinical Practicum in each academic year. Failures to put in /meet the required attendance by any student render him/her disqualified to appear in the

University exams. Condonation of attendance up to 10% (only once in the entire course) shall be granted by the head of the institution on genuine grounds, under intimation to controller of examinations. There shall be no condonation if attendance is below 70% percentage in theory classes and 80% in clinical practicum during each academic year. A candidate who does not have the required attendance will not be able to take examination or shall not be eligible to get admission for the next academic year. The Head of the institution should submit the Attendance performance certificate (APC) and conduct for every candidate as per university schedule.

#### **b. Internal Assessment**

**Theory:** It shall be based on periodical assessment, evaluation of student assignment, class presentation etc. Regular examination should be conducted throughout the course. Weightage for internal assessment shall be 20% of the total marks in each subject. There shall be 2 examinations and average will be taken as 50% of the internal assessment. The remaining 50% of the internal assessment will be based on day to day assessment.

**Clinical Practicum:** The internal assessment for clinical practicum shall be made by the faculty of concerned departments based on the clinical skills in assessment, remediation, clinical case presentation and clinical viva. The weightage of internal assessment for clinical practicum shall be 50 % of the total marks.

**The candidate must secure a minimum of 50% marks for internal assessment in a particular subject in order to be eligible to appear in the university examination of the subject.**

**The class average of internal assessment marks in each subject should not exceed 75%, both in theory and clinical practicum.**

### *3.6.2 Scheme and schedule of examination*

#### **a. Scheme of examination**

There shall be a university examination at the end of each academic semester. Duration of each theory paper shall be for 3 hours.

Clinical Examination: Clinical Examination shall be conducted by the designated internal faculty of the department at the end of first and third semester.

Clinical examination will be conducted by external examiners at the end of second and fourth semester. Student's performance on evaluation of clinical population should be assessed by the external examiner. An internal faculty member can assist the external examiner, but shall not award marks. The examiners shall also evaluate records of clinical and practical work of the student.

## **b. Schedule of Examination**

Supplementary examination will not be conducted for theory and clinical.

### *3.6.3 Question paper setting / pattern*

- Maximum mark for each theory paper shall be 80.
- Every theory paper shall comprise of five questions carrying 16 marks with internal divisions of 8 +8, 10 + 6 etc.
- The candidate should answer all the questions.
- Question paper setters shall be appointed from inside and/or outside the State
- Scrutiny of Question papers shall be done by the subject experts in respective faculties.

### *3.6.4 Scheme of valuation*

- The valuation will be conducted as per KUHS rules and regulations.

## **3.7 Criteria for pass and grace marks**

### *3.7.1 Criteria for pass*

- The student is required to obtain a minimum of 50% in each of the theory papers, internal assessment, practical and clinical exams, and dissertation for a pass.
- Students will have to pass the clinical examination of the given semester to proceed to the next semester.

- Carry-over of papers: Maximum number of attempts for any paper / clinical practicum / dissertation shall be three inclusive of first attempt. There shall be no supplementary examination.

### *3.7.2 Grace marks*

No grace mark shall be permitted for both theory and clinical examinations.

## **3.8 Declaration of class**

Successful candidates who obtain 75% and above marks are eligible for Distinction, 60% and above for First class and candidate who obtain 50% and above marks shall be declared to have passed the examination in Second class. Candidates who fail in first attempt in any subjects and pass subsequently shall not be ranked in distinction or first class.

## **3.9 Criteria for promotion**

The candidate must clear clinical examinations of each semester to be eligible to attend the next semester. Theory papers can be attempted along with the regular examination of consecutive batch. The candidate must clear all the papers of first, second, and third semester before the commencement of fourth semester M.Sc.(Aud) examination.

## **3.10 Rules for Supplementary batch / Additional batch**

No supplementary batch / additional batch will be allowed.

## **3.11 Qualification of Teacher / Examiner**

TEACHER: Post Graduation with 2 years of teaching/research/ clinical experience in the respective specialty.

EXAMINER: 3 years of teaching experience in the respective specialty after completion of Post-Graduation.

GUIDE: PhD in speech and hearing / 5 years of teaching experience after MASLP / MSc Speech & Hearing / M.Sc. Audiology.



### **3.12 Dissertation**

#### *3.12.1 Dissertation synopsis/Submission/Valuation*

Synopsis proforma should be submitted to the University within three months of joining the course. Students shall complete a dissertation in the 3<sup>rd</sup> and 4<sup>th</sup> semester of the course and shall submit two months before the commencement of 4<sup>th</sup> semester examination. An external examiner shall assess the dissertation for 80 marks while the guide shall assess the performance of the candidate for 20 marks (internal assessment). The dissertation will be rated for a total of 100 marks (80 +20). Candidates who fail to submit their dissertation on or before the stipulated date shall not be permitted to appear for the final semester examination. The student who fail to obtain 50% marks in dissertation will be declared as failed and will be ineligible to appear for both theory and clinical exams unless and he or she resubmit the dissertation within 45 days with modifications recommended by the external examiner.

#### *3.12.2 Standard format of dissertation*

The dissertation should be submitted in the APA format. The APA format is given in the annexure.

#### *3.12.3 Change of dissertation topic/Guide*

As per KUHS Regulations.

### **3.13 Migration and Transfer**

Migration and Transfer to other institutions within the University will not be allowed during the course of study.

### **3.14 Break of course - rules of re-admission**

If a candidate is not appearing in the College for more than six months, he / she, on the recommendation of the Head of the Institution should get permission from the University for re-joining. Re-admission will be considered strictly as per the KUHS regulation.

### **3.15 Period of completion of course**

The maximum permitted time period to complete the course is twice the duration of the Course. However each paper should be successfully completed within three attempts including the first one.

### **3.16 Eligibility of award of Degree**

The University shall award the M.Sc. Audiology degree and issue certificate only after the candidates successfully complete all the examinations stipulated.

## 4. COURSE CONTENT

### 4.1 Syllabus and scheme of examination

#### A) Scheme of curriculum for first semester

<b>CODES/PA PER NO</b>	<b>PAPER TITLE</b>	<b>TEACHING HOURS (MINIMUM)</b>	<b>EXAM DURATI ON</b>	<b>EXAM MARKS</b>	<b>IA MARKS</b>	<b>TOTAL MARKS</b>
A 101	Research Methods, Epidemiology and Statistics	60	3	80	20	100
A 102	Technology in Audiology	60	3	80	20	100
A 103	Cochlear Physiology	60	3	80	20	100
A 104	Physiological assessment of Hearing	60	3	80	20	100
A 105	Hearing Sciences	60	3	80	20	100
A 106	Clinical (Internal)	15 Hrs / week		100	-	100
Total						600

#### B) Scheme of curriculum for second semester

<b>CODES/PA PER NO</b>	<b>PAPER TITLE</b>	<b>TEACHING HOURS (MINIMUM)</b>	<b>EXAM DURATI ON</b>	<b>EXAM MARKS</b>	<b>IA MARKS</b>	<b>TOTAL MARKS</b>
A 201	Neurophysiology of Hearing	60	3	80	20	100
A 202	Auditory Perception	60	3	80	20	100
A 203	Auditory Disorders	60	3	80	20	100
A 204	Advances in the Management of Hearing Loss	60	3	80	20	100
A 205	Clinical (External)	15 Hrs/Week		80	20	100
Total						500

*C) Scheme of curriculum for third semester*

<b>CODES/PAPER NO</b>	<b>PAPER TITLE</b>	<b>TEACHING HOURS (MINIMUM)</b>	<b>EXAM DURATION</b>	<b>EXAM MARKS</b>	<b>IA MARKS</b>	<b>TOTAL MARKS</b>
A 301	Genetics of Hearing and Pediatric Audiology	60	3	80	20	100
A 302	Electrophysiological Assessment	60	3	80	20	100
A 303	Speech Perception	60	3	80	20	100
A 304	Auditory Processing Disorders	60	3	80	20	100
A 305	Vestibular System and its Disorders	60	3	80	20	100
A 306	Clinical ( Internal )	15 Hrs / Week		100	-	100
Total						600

*D) Scheme of curriculum for fourth semester*

<b>CODES / PAPER NO</b>	<b>PAPER TITLE</b>	<b>TEACHING HOURS (MINIMUM)</b>	<b>EXAM DURATION</b>	<b>EXAM MARKS</b>	<b>IA MARKS</b>	<b>TOTAL MARKS</b>
A 401	Audiology in Practice	60	3	80	20	100
A 402	Implantable Auditory Devices	60	3	80	20	100
A 403	Speech perception in clinical population	60	3	80	20	100
A 404	Dissertation			80	20	100
A 405	Clinical (External)	15Hrs /week		80	20	100
Total						500

## **Course Content**

### **M.Sc. (Audiology)**

#### **Semester I**

#### **A 101: Research Methods, Statistics & Epidemiology**

60 hours: 80 marks

**Objectives:** After completing this course, the student will be able to understand

- a. Clinical research designs and statistical methods,
- b. Epidemiological issues and its relevance in hearing research,
- c. Evidence based practice in Audiology, and
- d. Ethical practices in research

#### **Unit 1: Experimental Designs and Their Applicability in Hearing Research**

- Types of research- post facto research, normative research, standard group comparison, experimental research, clinical and applied research, sample surveys, evaluation research
- .Methods of observation and measurement, strategies and designs in research
- Experimental designs, single subject designs and group designs
- Critical analysis of the research methods employed in hearing research.
- Documentation and research writing
- Ethical considerations in research – National and international guidelines

#### **Unit 2: Epidemiology**

- Epidemiology: Definition, basic concepts – scope and function of epidemiology
- Study designs in epidemiology: Cohort studies, case-control studies, cross-sectional studies, clinical trials
- Measures in epidemiology – Ratios, proportions, rates, relative risk, odds ratio
- Identify biases and their consequences in published literature.
- Describe criteria for characterizing the causality of associations.
- Application of epidemiology in evaluation and screening procedures employed in Speech-language Pathology
- Application and impact of epidemiology on national and local policy; influence of epidemiology on ethical and professional issues

#### **Unit 3: Statistical Measures and their Features**

- Review of data description and exploratory data analysis (Numerical summaries and graphical summaries)
- Probability concepts and models
- Statistical Inference – Estimation Confidence Intervals
- Statistical Inference – Basic concepts related to hypothesis testing –null hypothesis, alternative hypothesis, significance level, statistically significant, critical value,

- acceptance / rejection region, p-value, power, types of errors: Type I ( $\alpha$ ), Type II ( $\beta$ ), one-sided (one-tailed) test, Two-sided (two-tailed) test
- Parametric and non-parametric approaches to hypothesis testing
- Categorical data analysis - contingency tables, Chi-square test for independence of attributes,
- Measures of association (Contingency coefficient, Cramer's V), Kappa coefficient

#### **Unit 4: Regression, Univariate and Multivariate Analysis**

- Correlation, regression analysis and prediction including multiple regression; logistic regression; path analysis
- Analysis of Variance (ANOVA)- Basic models, assumptions, one way and two way ANOVA; Consequence of failure of assumptions underlying ANOVA; Tests for additivity, homogeneity, transformation; Post – hoc tests; Analysis of Covariance (ANOCOVA); Repeated measure ANOVA
- Multivariate analysis: Need for multivariate analysis, various methods including
- MANOVA, MANCOVA
- Introduction to principal component analysis, factor analysis, discriminant function, multidimensional scaling
- Evaluation of application of statistics to different research designs used in different publications
- Critical analysis of research articles in the field: Analysis of research designs in different areas of Speech-language Pathology

#### **Unit 5: Evidence Based Practice**

- Introduction to Evidence Based Practice (EBP) and Steps to EBP from formulating foreground question, finding best current evidence, critical appraisal of best current evidence, summarizing evidence, integrating evidence and tracking progress.
- Concepts related to practical significance (effect size) vs. statistical significance, precision of measurement (confidence intervals)
- Levels of evidence: For experimental and non-experimental designs; treatment efficacy-randomized control study, quasi experimental study, correlation and case study, single subject designs, expert committee report, consensus conference
- Measures of diagnostic accuracy – positive and negative likelihood ratios; positive predictive value, negative predictive value, diagnostic odds ratio
- Concepts related to randomized control trials: Comparative groups- allocation concealment
- / random allocation; importance of participation and follow up in understanding, evaluating and applying randomized controlled trial results
- Methods of carrying out therapy trials; execution, indexing and reporting of therapy trials
  - Efficacy studies; Conventions to study outcomes - i) Absolute risk reduction, ii) Absolute benefit increase, iii) Absolute risk increase, and iv) Absolute benefit reduction
- Systematic review and meta-analysis; importance of research publications in terms of systematic review, meta-analysis, clinical practice guidelines, health technology assessments.
- Challenges in implementation of EBP in Audiology in India and future directions

## Recommended Reading

- Russell, C., & Jay, L. (2016). *Rehabilitation Research: Principles and Applications*. Elsevier
- Robert E. Owens Jr., Dale Evan Metz, Kimberly A. Farinella (2014). *Introduction to Communication Disorders: A Lifespan Evidence-Based Perspective*. Pearson Education
- Laura M. Justice, Erin Redle (2013). *Communication Sciences and Disorders: A Clinical Evidence-Based Approach*. Pearson Education.
- Robert F. Orlikoff, Nicholas E. Schiavetti, Dale Evan Metz (2014). *Evaluating Research in Communication Disorders*. Pearson Education
- David L. Irwin, Mary Pannbacker, Norman J. Lass (2013). *Clinical Research Methods in Speech-Language Pathology and Audiology*. Second Edition. Plural Publishing
- Timothy Meline (2009). *A Research Primer for Communication Sciences and Disorders*. Pearson Education
- David, L., Maxwell, EikiSatake. (2006) *Research and Statistical Methods in Communication Sciences and Disorders*. Thomson/Delmar Learning.
- John C Reinard (2006). *Communication Research Statistics*. SAGE Publications
- Nicholas Schiavetti, Dale Evan Metz (2006). *Evaluating Research in Communicative Disorders*. Allyn& Bacon
- Tim Pring (2005). *Research Methods in Communication Disorders*. Wiley
- Donald G. Doehring (2002). *Research Strategies in Human Communication Disorders*. Pro-Ed
- Carole E. Johnson, Jeffrey L. Danhauer (2002). *Handbook of Outcomes Measurement in Audiology*. Singular
- David L. Maxwell, EikiSatake (1997). *Research and Statistical Methods in Communication Disorders*. Williams & Wilkins

## **A 102: Technology in Audiology**

Hour – 60 Marks– 80

### **Objectives:-**

- a. To give an overview of the latest technology involved in Audiology, Signal processing, Instrumentation etc.
- b. To learn the various signal processing strategies used in hearing aid amplification, noise reduction, channel based gain and output control.
- c. To understand and observe the principle of working and functioning of equipments used for measurement of sounds and calibration of diagnostic equipments.
- d. To learn practically the procedure for calibration of audiometers, middle ear analyzer, Otoacoustic emission analyzer, BERA etc.
- e. To lay the foundation of ICT (Information and Communication Technology) concepts and illustrate the applications of ICT in Audiology
- f. To demonstrate practically the concepts in basic principle of operation of transducers, amplifiers, display units and other signal processing and signal acquisition elements of bio medical instrumentation in speech and hearing.

### **Unit 1: Introduction to Transducers and Signal Processing components**

- Basic principle of operation of Microphones, Headphones, Insert Receivers, Loudspeakers and Bone Vibrators
- Structure and working of Preamplifiers, Main amplifiers and Power amplifiers Introduction to Batteries, AC and DC Power supplies
- Introduction to Computers, Peripherals, computer networks, Operating systems and Application Softwares.

### **Unit 2: Introduction to Digital signal processing and Communication technology**

- Block diagram of a digital signal processing system
- Principle and Functioning of Analog to Digital converter and Digital to Analog converter Fundamental concepts of Digital Signal Processing - Decomposition, Processing and Synthesis
- Implementation of Filters using DSP
- Implementation of Amplifiers using DSP
- Basic technique of amplitude and frequency modulation, structure of amplitude modulator, frequency modulator and pulse modulation systems.
- Satellite communication and implementation of teleradiology & telerehabilitation system.



### **Unit 3: Signal processing in hearing aids, Speech processing and analysis**

- Block diagram of analog and digital hearing aids and their comparison.
- Basic architecture of amplifiers in digital hearing aids]
- Signal processing techniques in channel separation, non-linear amplification, output limiting, noise control, feedback cancellation etc.
- Block diagram, structure, implementation, merits and demerits of group hearing aids and assistive listening devices.
- Basic architecture of speech processor in cochlear implants, its principles of working and speech processing strategies.
- Fundamentals of Matlab based signal processing and its application in audiology.
- Representation of a speech waveform in time and frequency domain
- Short time analysis techniques

### **Unit 4: Instrumentation in Audiology**

- Basic structure and functioning of equipment and components used for measurement of sound and calibration
- Block diagram, functional description and calibration procedure for :
  - Audiometer
  - Middle ear Analyzer
  - Otoacoustic Emission Analyzer
  - Instrumentation for Auditory Evoked Potential
- Importance of grounding, procedure for making a perfect electric ground, checking the perfection of an electric ground.
- Procedure for noise auditing.
- Room acoustics, factors to be considered while constructing an audiometric test room, sound proofing techniques.
- Procedure for measurement of reverberation time

### **Unit 5: Neuro Imaging and Tele- technology**

- Principles of neuro imaging techniques - MRI, fMRI, NIRS, CT, PET, SPECT, TMS and MEG and their technology (working principles, interpretation and implications).
- Tele-technology: Definition, applications, technology, resources
- Transmission of information: transmission of patient images, reports, etc.
- Remote consultations and databases
- Distance learning- multimedia meeting room / videoconferencing

### **Recommended reading**

- The Acoustic Analysis of Speech Singular Publishing Group. Kent, Ray D. K., Read, Chales.
- Digital Processing of Speech Signals. Prentice-Hall Inc. Lawrence R. Rabiner, Schafer, Ronald W.

- Introduction to Digital Signla Processing. Prentice-Hall of India Pvt., Ltd. Johnson, R.
- Applications of Digital Signal Processing to Audio and Acoustics. Kulwer Academic Publishers. Brandenburg, Kerlheinz.
- Digital Signla Processing. Prentice Hall of India Pvt. Ltd. Oppenheim Av Schafer, Ronald W.
- Science of Sound. Addison Wesley 3<sup>rd</sup> Ed. Richard Moore, Ruossing, Thomas D. Wheeler Paul A.
- Encyclopedia of Acoustics. John Wiley andSons. Crocker, Malcoem

## **A 103: Cochlear Physiology**

60 hours: 80 marks

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

- a) The different parts of the peripheral auditory system
- b) The functioning of normal peripheral auditory system
- c) The methods used to study auditory physiology
- d) Give insights into the physiological basis of physiological tests used for hearing assessment
- e) Applying the knowledge of auditory physiology to take appropriate clinical decisions

### **Unit 1: Introduction to Conductive mechanism of auditory system**

- External Ear: Anatomy and physiology of lower animals & humans
  - Role of Pinna & External auditory meatus in hearing.
  - Resonance properties of external ear in human.
- Temporal bone anatomy.
- Middle ear: Anatomy & Physiology of lower animals 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**

- Cochlea: Anatomy in lower animals and human
- Macro & microanatomy
- Blood supply of inner ear
- Innervations of inner ear
- Proteins in the cochlea
- Cochlear regeneration
- Auditory system in lower animals

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

- Modes of bone conduction
- Cochlear fluids - Origin, composition, absorption, and dynamics
- Cochlear mechanics - basilar membrane mechanics -historical and current status.
- Cochlear transduction
- Cochlear electrophysiology
- Cochlear non-linearity - two tone suppression, otoacoustic emission & other recent advances.
- Nutrients related to sensory cell physiology

- Physiology of auditory system in lower animal

#### **UNIT 4: Cochlear Potentials**

- Endocochlear potentials.
- Electrocochleography: Instrumentation and technique
- Protocol for recording ECoChG
- Interpretation of ECoChG
- Clinical application of ECoChG

#### **Unit 5: Theories of hearing**

- Historical aspects.
- Place theory - resonance & nonresonance.
- Frequency theory.
- Traveling wave theory.
- Other recent advances like motor theory etc.

#### **Recommended reading**

- Beagly, H. A. (1981). Audiology & Audiological medicine. Oxford: Oxford university press.
- Bekesy, G. V. (1960). Experiments in hearing. New York: McGraw Hill.
- De Reuck, A. V. S & Knight, J. (1968). Hearing mechanisms in vertebrates. London: Churchill.
- Davis, D. V. (1969). Gray's anatomy: descriptive & applied. New Delhi: Orient Longmans.
- Gelfand, S A. (2004). Hearing: Introduction to Psychological and Physiological Acoustics. (4th. edn.). New York, Marcel Decker
- Guinan, J. J. & Peake, W. T. (1967). Middle ear characteristics of anesthetized cats. *Journal of Acoustical Society of America*, 41, 1237-61.
- Gulick, W. L. & Others. (1989). Hearing: Physiology, acoustics, neural coding & psychoacoustics. New York: Oxford university press.
- Jahn, A. F & Santos-Sacchi, J (1989). Physiology of the Ear. New York: Academic press.
- Keidel, W. D. & Neff, W. D. (1974). Handbook of sensory physiology. Berlin: Springer.
- 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.
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- Moller, A. R. (2000). Hearing: Its physiology and pathology. San Diego: Academic press.
- Moore, B. C. J. (1995). Hearing. San Diego: Academic press.
- Popelka, G. R. (1981). Hearing assessment with acoustic reflex. New York: Grune & Stratton Press.
- Yost, S. A. (1994). Fundamental of hearing: An introduction. San Diego: Academic Press, Inc.
- Zemlin, W. R. (1998). Speech & Hearing science: Anatomy & Physiology. Boston: Allyn & Bacon.

- Berlin, C. I (1996). Hair cells and hearing aids. San Diego: Singular publishing group.
- Brown, R. D & Daigneault, E. A. (1981). Pharmacology of hearing. New York: Wiley.
- Dallos, P. (1973). Auditory periphery: Biophysics & physiology. New York: Academic press.
- Dallos, P., Popper, A. N. & Fry, R. R (1996). The cochlea. New York: Springer.
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- 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.
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- Zemlin, W. R. (1998). *Speech & Hearing science: Anatomy & Physiology*. Boston: Allyn& Bacon.
- Bekesy, G. V. (1960). *Experiments in hearing*. New York: McGraw Hill.
- Bradford, L. J. (1975). *Physiological measures of the audio-vestibular system*. New York: academic press.
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- Highstein, S. M., Fay, R. R., & Popper, a. N. (2004). *Vestibular system*.
- Jackler, R. K. &Brackmann, D. E. (2005). *Neuro-otology*. New York: Elsevier .
- Jacobson, G. A., Newman, C. W., &Kartush, J. M. (1997). *Handbook of balance function testing*.
- Nauton, R. F. (1975). *The vestibular system*. New York: Academic press.
- Waver, E. G. (1970). *Theories of hearing*. New York: Dover.
- Zemlin, W. R. (1998). *Speech & Hearing science: Anatomy & Physiology*. Boston: Allyn& Bacon.

## **A 104: Physiological Assessment of Hearing**

60 hours: 80 marks

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

- a) Describe the bases of physiological tests
- b) Interpret physiological test findings
- c) Explain the importance of different tests required for assessment of physiological mechanism of auditory system.
- d) To select appropriate test parameters for assessing conductive and sensorineural mechanism

### **Unit 1 – Tympanometry**

- Principle and instrumentation of immittance evaluation
- Tympanometry: Low frequency Vs. Multifrequency tympanometry,
- Single vs. Multicomponent tympanometry,
- Variables affecting tympanometry
- Tympanometry in infants
- Tests used to assess Eustachian tube function
- Implication of tympanometric evaluation in differential diagnosis and management

### **Unit 2 - Reflexometry**

- Acoustic and non-acoustic reflexes,
- Reflex adaptation, latency of acoustic reflex, reflex averaging, reflex sensitization
- Temporal summation of acoustic reflex, binaural summation of acoustic reflex
- Variables effecting their measurement of acoustic reflexes
- Importance of high frequency reflexometry in paediatric assessment
- Implication of acoustic & non acoustic reflexes in differential diagnosis and management
- Reflectometry
- Research needs in immittance evaluation.

### **Unit 3: Otoacoustic emissions**

- Origin of OAEs,
- Classifications of OAEs
- Principles in recording of OAEs
  
- Interpretation of OAEs: Amplitude, latency, phase, and reproducibility
- Instrumentation of SOAE
- Recording of SOAE
- Synchronized SOAE
- Factors affecting SOAE

- SOAE & Tinnitus
- Clinical applications of SOAE
- Suppression of SOAE

#### **Unit 4: Evoked otoacoustic emission**

- Instrumentation of TEOAE/DPOAE/SFOAE
- Recording of TEOAE/DPOAE/SFOAE
- Factors affecting TEOAE/DPOAE/SFOAE
- Fine structure DPOAE
- Evoked OAEs & Tinnitus
- Clinical applications of TEOAE/DPOAE/SFOAE
- Contralateral & ipsilateral suppression of TEOAE/DPOAE/SFOAE
- Implication in differential diagnosis and management,
- Research needs in OAE

#### **Unit 5: Assessment of auditory disorders in the special population**

- Assessment of patients with hyperacusis
  - condition/disorders in which it occurs
  - tests, interpretation
  - implications of findings in rehabilitation
- Assessment of patients with Tinnitus
  - Condition associated with tinnitus
  - Types of tinnitus
  - Evaluation
  - Implications of findings in rehabilitation
- Assessment of patients with Dead region

#### **Recommended reading:**

- Feldman, A S. & Wilber L A. (1976). Acoustic immittance & admittance. Williams & Wilkins Comp
- Jerger, J (1975). Hand book of clinical impedance audiometry, American Publisher Electromedics Corp.
- Silman, S. & Silverman, C.A.(1991). Auditory Diagnosis: Principles & Applications, San Diego, Academic Press.
- Wiley, T.L. and Fowler, C.G. (1997). *Acoustic immittance measures in clinical audiology: A primer*. San Diego: Singular Publishing Group, Inc.
- Berlin, C.I. (Ed.) (1996). *Hair cells and hearing aids*. London: Singular publishing group.
- Berlin, C. I., Hood, L. J., and Ricci, A. (2002). Hair Cell Micromechanics and Otoacoustic Emissions. Thomson Learning Inc., New York.



- Hall, J. W. (2000). *Handbook of Otoacoustic Emissions*. Singular Publishing Company, San Diego.
- Musiek, F. E., and Rintelmann, W. F. (1999). *Contemporary Perspectives in Hearing Assessment*. Allyn and Bacon, Boston.
- Robinette, M. S., and Glatcke, T. J. (2007). *Otoacoustic Emissions: Clinical Applications* (3rd edition). Thieme Publishers, New York.
- Roeser, R. J., Valente, M., and Dunn, H. H. (2007). *Audiology: Diagnosis*. Thieme Publishers, New York.
- Christopher.A.Shera (2004) Mechanism for mammalian OAE and their implication for the clinical utility of OAE. *Ear & Hearing*, .Vol.25, No.2.
- Joint Committee on Infant Hearing. (2007). Year 2007 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs. *Pediatrics*, 120, 898-921.
- Rudolf Probst- A Review of otoacoustic emissions *JASA* 89(5) pgs- 2027-2067
- Shera&Guinan (1999) Evoked otoacoustic emissions arise by two fundamentally different mechanism: A taxonomy for mammalian cochlea *JASA*, 105 (2)
- Sahley, T.L., Nodeer, R.H. and Musiek, F.E. (1997). *Efferent auditory system: Structure and function*. San Diego: Singular Publishing Group, Inc.
- Kemp, D. T. (1978). Stimulated acoustic emissions from within the human auditory system, *Journal of Acoustical Society of America*, 64, 1386-1391.
- Mills, D. M., &Rubel, E. W., (1994). Variation of distortion product otoacoustic emissions with furosemide injection, *Hearing Research*, 77, 183-199.
- Katz, J. (Ed.). (1994). *Handbook of Clinical Audiology*. Baltimore: Williams and Wilkins.
- Hall, J.W. and Mueller, H.G. (1997) *Audiologists' Desk Reference* Volume 1: Diagnostic Audiology Principles, Procedures and Protocols, Singular Publishing Group: San Diego.
- Rintleman, W.F. (1991). *Hearing Assessment*. Boston: Allyn and Bacon.
- Roser, R.R., Valente, M &Hosford-Dunn, D (Eds) (2000). *Audiology: Diagnosis*, New york, Thieme.
- Van De Water, T.R., Popper, A.N. and Fay. R.R. (Ed) (1996). *Clinical aspects ofhearing*. New York: Springer

## **A 105: Hearing Sciences**

Marks -80: Hours - 60

**Objectives:** After completing this course, the student will be able to

- a) Understand psychophysical components of sound and their measurement,
- b) Analyse and critically evaluate the different methods of estimation of thresholds, frequency analysis and application of masking, and
- c) Conduct experiments to estimate thresholds, measure pitch.

### **Unit 1: Introduction to Psychoacoustics**

- Physical description and parameters for generation of sounds: Sine wave and complex signals; Analysis of sound: Spectrum and spectrogram, LTASS; Filters and their properties
- Theory of signal detection: Basic concepts and applications of signal detection
- Psychophysical methods - Classical and adaptive methods

### **Unit 2: Thresholds and Loudness**

- Overview of absolute and relative measures: Methods of measuring absolute and relative thresholds; thresholds of audibility (MAP & MAF); Models of loudness.
- Loudness perception in normal hearing persons
- Effect of hearing impairment on perception of loudness
- Dynamic range of hearing, equal loudness contours and loudness scaling.
- Recruitment and softness imperceptions
- Consequences of altered loudness perception
- Factors affecting loudness: Bandwidth, duration, adaptation and masking.
- DLI

### **Unit 3: Pitch**

- Theories of pitch perception - simple and complex signals
- Pitch scales
- Factors affecting pitch perception
- Perception of pure-tones by persons with normal hearing and those with hearing impairment
- Perception of complex signals by persons with normal hearing and those with hearing impairment
- DLF

### **Unit 4: Peripheral Masking**

- Critical band concept and power spectrum model
- Estimating the shape of auditory filter: Psycho-physical tuning curve; Notched noise; Non-simultaneous masking, TEN test.
- Auditory filter shapes in normal hearing and hearing impaired
- Masking patterns and excitation patterns in normal hearing and hearing impaired

## **Unit 5: Non-Peripheral Masking**

- Central masking
- Informational masking
- Overshoot phenomena
- Co-modulation masking release
- Effect of hearing loss on non-peripheral masking

### **Recommended Reading**

- Brain C.J., Moore (2007). Cochlear Hearing Loss: Physiological, Psychological and Technical Issues. England: John Wiley and Sons Ltd.
- Brain, C.J. Moore (1998). Cochlear Hearing Loss. (2nd and 3rd Editions). London: Whurr Publishers.
- Gelfand, S, A. (2005). Introduction to psychological and physiological acoustics. New York: Marcel Dekker.
- Gullick, W.L. (1971). Hearing physiology and psychophysics. New York: Oxford University Press.).
- Howard, D and Angus, J ( 2013). Acoustics and Psychacoustics. Oxford: Taylor & Francis
- Moore, B. C. J. (1995). Hearing. San Diego: Academic Press.
- Stanley, A. Gelfand (1998). Hearing. New York: Marcel Dekker Inc.
- Stuart Rosen & Deter Howell (1991). Signals and systems for speech and hearing. CA: Academic Press Inc.
- Stuart Rosen and Deter Howell (1991). Signals and systems for speech and hearing. CA: Academic Press Inc
- Yost, W. A. (1994). Fundamentals of hearing: An introduction. San Diego: Academic Press.
- Zwicker, E., &Fastl, H. (1999). Psychoacoustics-Facts and models. Springer Verlag: Berlin Heidelberg.



## Semester II

### A 201: Neurophysiology of Hearing

60 hours: 80 marks

#### Objectives:

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

- a) The different parts of the auditory nervous system and efferent auditory system
- b) The functioning of normal auditory nervous system and efferent auditory system
- c) The methods used in auditory neurophysiology
- d) Give insights into the physiological basis of electrophysiological tests used for hearing assessment
- e) Applying the knowledge of auditory neurophysiology to take appropriate clinical decisions

#### Unit 1 Anatomy & physiology of the auditory nerve & neurotransmitter

- Structure and tonotopic organization of auditory nerve .
- Electrophysiology - Action potential, generation and properties.
- Stimulus coding - frequency, intensity and temporal coding.
- Non-linearity seen at auditory nerve.
- Type of synapse
- Physiology of the nerve
- Neuro-transmitters vs neuro modulator
- Properties and function of neuro transmitter
- Afferent and efferent neuro transmitters

#### Unit 2: Anatomy of the central auditory pathway

##### *Anatomy of the ascending auditory pathway*

- Cochlear nucleus
- Superior olivary complex
- Lateral lemniscus
- Inferior colliculus
- Medial geniculate body
- tonotopic organization at the different levels.

#### UNIT 3: Physiology of the central auditory pathway

##### *Physiology of the ascending auditory pathway*

- Neurophysiology
  - Different types of cell pattern
  - Coding of the stimulus parameters.
  - Coding of the complex acoustic signal
- Response patterns observed at the different levels
- Physiology of sound localization

#### **Unit 4: Auditory Cortex:**

- Anatomy and tonotopic organization of the primary and secondary auditory area.
- Classifications of the auditory cortex
- Neurobiological relationship between auditory cortex and other areas
- Neurophysiology of the auditory area.
  - Coding of the stimulus parameters.
  - Coding of the complex acoustic signal
- Vitamins influencing physiology of the auditory nervous system
- Plasticity of the auditory cortex

#### **Unit 5: Anatomy & physiology of the efferent pathway & cranial nerves related to ear**

- 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
- Non-classical auditory pathway
- Physiology of the efferent system
- Effect on cochlear physiology and auditory nerve and CN.
- Perception of auditory stimulus.
- Protective function.
- Anatomy of the cranial nerves related to ear.

#### **Recommended reading**

- The auditory system: anatomy, physiology and clinical correlates. Authors: [Frank E. Musiek](#), [Jane A. Baran](#).
- Physiology of the ear. By Anthony F. Jahn, Joseph Santos-Sacchi.
- Hearing: an introduction to psychological and physiological acoustics. Author/s: Gelfand S.A
- The Mammalian auditory pathway: neuroanatomy: By Douglas B. Webster, Arthur N. Popper, Richard R. Fay.
- The Mammalian auditory pathway: neurophysiology: By Douglas B. Webster, Arthur N. Popper, Richard R. Fay
- An introduction to the physiology of hearing: James O Pickels
- [Günter Ehret, R. Romand](#) (1997). The central auditory system. Oxford University Press.
- Neurobiology of Hearing: Altsucher Richard
- [Enrique A. Lopez-Poveda](#) (2010). The Neurophysiological Bases of Auditory Perception. Springer Link.
- [Adrian Rees, Alan R. Palmer](#) (2010). The Oxford Handbook of Auditory Science: The Auditory Brain. Oxford University Press.
- [David Moore, Alan Palmer, Paul Fuchs](#) (2010). Oxford handbook of auditory science the ear. Oxford University Press

- The Mammalian auditory pathway: neuroanatomy: By Douglas B. Webster, Arthur N. Popper, Richard R. Fay.
- The Mammalian auditory pathway: neurophysiology: By Douglas B. Webster, Arthur N. Popper, Richard R. Fay
- Physiology of the ear. By Anthony F. Jahn, Joseph Santos-Sacchi.
- [Jeffery A. Winer, Christoph Schreiner](#) (2005). The inferior Colliculus. Springer Link.
- Lambert M. Surhone, Miriam T. Timpledon, Susan F. Marseken (2010). Superior Olivary Complex. Betascript Publishers.
- Listening to Speech: auditory perspectives. By Steven Greenberg, William Anthony Ainsworth
- Speech processing in the auditory system: Steven Greenberg.
- [Enrique A. Lopez-Poveda](#)(2010). The Neurophysiological Bases of Auditory Perception. Springer Link.
- Neurobiology of Hearing: Altsucher Richard
- [Enrique A. Lopez-Poveda](#)(2010). The Neurophysiological Bases of Auditory Perception. Springer Link.
- [Adrian Rees, Alan R. Palmer](#) (2010). The Oxford Handbook of Auditory Science: The Auditory Brain. Oxford University Press.
- [David Moore, Alan Palmer, Paul Fuchs](#) (2010). Oxford handbook of auditory science the ear. Oxford University Press.
- Acoustical signal processing in the central auditory system. By Josef Syka
- [Reinhard König](#)(2005). The auditory cortex: a synthesis of human and animal research. Routledge Publishers.
- [Jasper R. Daube, Devon I. Rubin.](#) (2009). Clinical neurophysiology. Oxford University Press.
- Listening to Speech: auditory perspectives. By Steven Greenberg, William Anthony Ainsworth
- Speech processing in the auditory system: Steven Greenberg.
- [Enrique A. Lopez-Poveda](#)(2010). The Neurophysiological Bases of Auditory Perception. Springer Link.
- The Mammalian auditory pathway: neuroanatomy: By Douglas B. Webster, Arthur N. Popper, Richard R. Fay.
- Physiology of the ear. By Anthony F. Jahn, Joseph Santos-Sacchi.
- [Enrique A. Lopez-Poveda](#)(2010). The Neurophysiological Bases of Auditory Perception. Springer Link.
- The auditory cortex: structural and functional bases of auditory perception. Lindsay Aitkin.
- Plasticity and signal representation in the auditory system. By Josef Syka, Michael M. Merzenich.
- Computational Models of the Auditory System. By Ray Meddis
- Acoustical signal processing in the central auditory system. By Josef Syka

- Lambert M. Surhone, Miriam T. Timpledon, Susan F. Marseken (2010). Superior Olivary Complex. Betascript Publishers.
- The Mammalian auditory pathway: neuroanatomy: By Douglas B. Webster, Arthur N. Popper, Richard R. Fay.
- The Mammalian auditory pathway: neurophysiology: By Douglas B. Webster, Arthur N. Popper, Richard R. Fay
- Physiology of the ear. By Anthony F. Jahn, Joseph Santos-Sacchi.
- The efferent auditory system: basic science and clinical applications. BY Charles E. Berlin.
- Efferent auditory system: structure and function. By [Tony L. Sahley, Richard H. Nodar, Frank E. Musiek.](#)
- Auditory and Vestibular Efferents. By David K. Ryugo.
- Acoustical signal processing in the central auditory system. By Josef Syka



## **A 202: Auditory Perception**

Marks -80: Hours - 60

**Objectives:** After completing this course, the student will be able to

- a) Understand the processes involved in the perception of speech by persons with normal and impaired hearing, and
- b) Apply principles of speech perception in therapy and research.

### **Unit 1: Temporal processing**

- Overview of temporal processing: temporal resolution; temporal integration; models of temporal processing
- Detection and discrimination of gaps in normals and individuals with hearing impairment
- Temporal modulation transfer function in normals and individuals with hearing impairment
- Temporal integration in persons with normal hearing and those with hearing impairment
- Models of temporal processing in persons with normal hearing and those with hearing impairment

### **Unit 2: Auditory object and pattern perception**

- Basic concepts in auditory object perception
- Spectral cues for object perception
- Temporal cues for object perception
- Auditory pattern perception in individuals with normal hearing and those with hearing impairment
- Timber perception
- Time invariant-pattern and time varying pattern perception

### **Unit 3: Adaptation**

- Adaptation vs. fatigue
- Methods of studying adaptation
- Adaptation in in persons with normal hearing and those with hearing impairment
- Neurophysiological basis of adaptation
- Factors affecting adaptation

### **Unit 4: Perception in Space**

- Perception of distance: localization vs. lateralization; localization of pure tones; localization of complex signals
- Effect of hearing loss on localization
- Monaural localization
- Factors affecting localization
- Neurophysiology of localization

## **Unit 5: Binaural hearing and Perception of Music**

- Binaural hearing - overview
- Models of binaural hearing
- Masking level difference
- Musical scales/Musical notes
- Factors affecting perception of music

### **Recommended Reading**

- Brain, C.J. Moore (1986). Frequency selectivity in Hearing. CA: Academic Press Inc.
- Diana Deutsch (2013). The Psychology of Music, Third Edition (Cognition and Perception) 3rd Edition. Academic Press
- Gelfand, S, A. (2005). Introduction to psychological and physiological acoustics. New York: Marcel Dekker.
- Howard, D and Angus, J ( 2013). Acoustics and Psychacoustics. Oxford: Taylor & Francis
- M. Riess Jones, R.R. Fay, A.N. Popper (2010). Music Perception. Springer
- Oxenham, A., & Bacon, S. (2003). Cochlear Compression: Perceptual Measures and Implications for Normal and Impaired Hearing. *Ear and Hearing*, 24, 350-366.
- Plack, C.J., Oxenham, A.J., & Fay, R.R. (2005). Pitch: Neural Coding and Perception. New York: Springer.
- Stanley, A. Gelfand (1998). Hearing. New York: Marcel Dekker Inc.
- Warren, R. M. (2008). Auditory Perception: An Analysis and Synthesis. Cambridge: Cambridge University Press.
- Yost, W. A. (1994). Fundamentals of hearing: An introduction. San Diego: Academic Press.
- Zwicker, E., &Fastl, H. (1999). Psychoacoustics-Facts and models. Springer: Verlag Berlin Heidelberg.

## **A 203: Auditory Disorders**

Marks -80: Hours - 60

**Objectives:** After completing this course, the student will be able to

- a) Explain the pathophysiology of auditory disorders,
- b) Diagnose and differentially diagnose auditory disorders, and
- c) Recommend appropriate management options for the clients with hearing loss.

### **Unit 1: Disorders of the External and Middle Ear**

- Congenital malformations of external and middle ear
- 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
- Diseases of the middle ear cleft: otosclerosis otitis media, non suppurative otitis media, complications of middle ear diseases, neoplasms.
- Assessment of middle ear functioning: multicomponent tympanometry, multifrequency tympanometry, wide band reflectance/absorbance, reflexometry
- Reconstruction of external and middle ear hearing mechanisms: reconstructive and rehabilitation procedures

### **Unit 2: Disorders of the Cochlea**

- Pathophysiology inner ear disorders: ototoxicity, Meniere's, age related hearing loss, Sudden hearing loss, auto immune conditions, hearing loss due to systemic diseases
- Audiological profile in persons with above inner ear disorders
- Nonaudiological management options

### **Unit 3: Disorders of the Cochlea– NIHL &Traumatic Injury**

- Pathophysiology inner ear disorders due toNIHL and other traumatic injuries
- Audiological profile in persons with NIHL and other traumatic injuries
- Hearing conservation: National and International guidelines
- Nonaudiological management options

### **Unit 4: Auditory Nerve and Brainstem**

- Pathophysiology of space occupying lesions of auditory nerve and brainstem
- Audiological profile in persons with space occupying lesions
- Radiological findings and its correlations with audiological findings
- Challenges in diagnosis of space occupying lesion
- Management options for space occupying lesion

### **Unit 5: Auditory Neuropathy Spectrum Disorders**

- Pathophysiology of ANSD
- Etiology of ANSD
- Audiological profile of persons with ANSD and its correlations with pathophysiology

- Speech perception in persons with ANSD
- Management of persons with ANSD: Aids strategies

### **Recommended Reading**

- Berlin, C. I., Hood, L. J., & Ricci, A. (2002). Hair Cell Micromechanics and Otoacoustic Emissions. New York: Thomson Learning Inc.
- Chasin, M (2009) Hearing Loss in Musicians: Prevention and Management. San Diego: Plural Publishers
- Hall, J. W. (2000). Handbook of Otoacoustic Emissions. San Diego: Singular Publishing Company.
- Hall, J.W. (2007). New Handbook of Auditory Evoked Responses. Boston: Pearson.
- Hood, L.J. (1998). Clinical applications of auditory brainstem response. San Diego: Singular Publishing Group Inc.
- Moller, A. R. (2000). Hearing: Its physiology and pathology. San Diego: Academic Press.
- Rintleman, W.F. (1991). Hearing Assessment. Boston: Allyn and Bacon.
- Roeser, R. J., Valente, M., & Hosford-Dunn, H. (2007). Audiology: Diagnosis. New York: Thieme Medical Publishers.
- Sanbridge, S.A. (2009). Ear Disorders. San Diego: Plural Publishers
- Sininger, Y& Starr, A (2001). Auditory Neuropathy: A new perspective in hearing disorders
- Standring, S. (2008). Gray's Anatomy: The Anatomical Basis of Clinical Practice, Expert Consult. Livigstone: Churchill publishers.
- Wiley, T.L., & Fowler, C.G. (1997). Acoustic immittance measures in clinical audiology: A primer. San Diego: Singular Publishing Group Inc

## **A 204: Advances in the Management of Hearing Loss**

Hours - 60 : Marks - 80

**Objectives:** At the end of the course, the students should be able to

- a) Understand the different amplification/assistive devices and their changing technology
- b) Explain the strategies of device selection and optimization
- c) Develop need-based programs and intervention strategies for persons with different types of hearing impairment across age groups, and
- d) To list specific needs and know psychosocial and communicative demands and strategies to solve these

### **Unit 1: Advances in Hearing Aid and Hearing Assistive Technology**

- Application of recent advances in hearing aids and hearing assistive technology : 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, Personal amplification systems
- Techniques to control acoustic feedback, distortion, circuit noise: Electromagnetic interference – measurement, solutions; techniques to improve compatibility of hearing aids with mobile phones
- Application of LASER technology in ear mold production, ear mold modifications for enhancing listening comfort – physical and acoustic modifications
- Electroacoustic measurement of hearing aids: Variables affecting electroacoustic measurements and its implications
- International and Indian standards/legislations for hearing aids and ALDs.

### **Unit 2: Selection and Fitting of Hearing Aid and Hearing Assistive Devices**

- Selection, verification and validation of hearing aids and hearing assistive devices: Pre-selection, selection an assessment of listening needs
- Objective procedures for hearing aid fitting (ABR, ALLR, ASSR and others):
- Hearing aid programming, optimization, verification and validation
- Hearing aid fitting for children : pre-selection, selection, verification and validation: Different protocols used
- Hearing aid fitting for persons with different types of hearing loss (Sudden hearing loss, unilateral hearing loss, High frequency hearing loss, Cochlear dead region)
- Future trends in hearing aids and HATs: Technology and fitting strategies

### **Unit 3: Speech Perception Through Hearing Aids**

- Factors affecting speech perception through hearing aids and hearing devices: Auditory plasticity
- Methods to improve speech perception through hearing aids and hearing devices: Speech cue enhancement – spectral shape, duration, intensity, enhancement of CVR, speech simplification, re-synthesis, enhancement of perception of telephone speech
- Emerging technology for better speech perception
- Noise reduction algorithms and nanotechnology in hearing aids

#### **Unit 4: Rehabilitation of Individuals with Hearing Impairment**

- Counseling of users of hearing aid and hearing assistive devices: techniques: Realistic expectations, adjusting to hearing device, other management options
- Care and maintenance of hearing aid and hearing assistive devices
- Trouble shooting and fine tuning/optimization of hearing aids and assistive devices
- Management of children with hearing impairment: Criteria for selecting different auditory listening programs; 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
- Rehabilitation of adults and older adults: auditory listening / speech reading training for older adults: variables that affect the communication and the role of the communication partner: auditory plasticity: Planning training activities; assertiveness training
- Quality of life of hearing impaired and its enhancement: Outcomes of different management strategies across age groups: Methods and measures

#### **Unit 5: Management of the children/adult with Multiple Disabilities and other Hearing Related Disorders**

- Management of children and adults with multiply disability: 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: educational and vocational placement, role of caregivers and outcome measures
- Audiological management of tinnitus: characteristics, assessment of tinnitus, basis and theories 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, counseling, others) and their outcomes
- Audiological management of persons with hyperacusis: Models related to hyperacusis management; overview to non-audiological management techniques for hyperacusis Audiological management techniques for normal hearing and different degrees of hearing loss and their outcomes

#### **Recommended Reading**

- Atcherson, S. R., Franklin, C. A., & Smith-Olinde, L. (2015). Hearing assistive and access technology. San Diego: Plural Publishing Inc.
- Dillon, H. (2012). Hearing Aids. 2nd Edn. Australia: Boomerang Press.
- Martini, A., Mazzoli, M., Read, A., & Stephens, D. (2001). Definitions, Protocols and Guidelines in Genetic Hearing Impairment. England: Whurr Publishers Ltd.
- Metz, M. J. (2014). Sandlin's textbook of hearing aid amplification. 3rd Edn. San Diego: Plural publishing Inc.

- Schaub, A. (2008). Digital hearing aids. New York: Thieme Medical publishers.
- Mueller, H. G., Rickettes, T. A., & Bentler, R. (2014). Modern hearing aids: Pre-fitting
- Testing and selection considerations. San Diego: Plural Publishing Inc.
- Sandlin, R.E. (1995). Handbook of Hearing aid amplification – clinical consideration and fitting practices. London: Singular Publishing Group.
- Tyler, R.S., & Schum, J. (1995). Assistive devices for persons with hearing impairment. United States of America: Allyn&Baccon.
- Cole, E.B., & Carol, F. (2007). Children with hearing loss- Developing Listening & Talking. United States of America: Plural Publishing Inc.
- Estabrooks, W. (2006). Auditory Verbal Therapy & Practice. United States: Alexander Graham Bell Association for the Deaf and Hard of Hearing Inc.
- Hull, R. H. (2014). Introduction to aural rehabilitation. 2nd edn. San Diego: Plural publishing Inc.
- Tye-Murray, N. (2015). Foundations of aural rehabilitation-Children, Adults & Their family members. 4th Edn. United States of America: Stamford, Cengage Learning.
- Baguley, D. M., & Andersson, G. (2007). Hyperacusis: Mechanisms, Diagnosis and Therapies. San Diego: Plural Publishing Inc.
- Hersh, M. A., & Johnson, M. A. (2003). Assistive Technology for the hearing-impaired, Deaf and Deaf-blind. Nottingham: Springer-Verlag London Ltd.
- Jastreboff, P.J., & Hazell, J.W.P. (2004). Tinnitus retraining therapy-implementing the Neurophysiological model. United Kingdom: Cambridge University Press.
- Johnson, C. E. (2012). Introduction to auditory rehabilitation: A contemporary issues
- approach. New Jersey: Pearson Education, Inc.
- Wong, L., & Hickson, L. (2012). Evidence-based practice in audiology: Evaluating interventions for children and adults with hearing impairment. San Diego: Plural Publishing Inc.

## **A 106 &A 205: Clinicals in Audiology**

### **General considerations:**

- a) The student should be able to carry out complete audiological evaluation and management of persons with hearing impairment.
- b) After completion of clinical postings, the student will have the ability to apply, show (in a clinical diary/log book), and perform the following on patients/clients:

### **Know-how**

- a) Make appropriate changes in OAE protocols depending on the clinical / research needs
- b) Develop protocol for recording exogenous and endogenous auditory evoked potentials
- d) Integrate the results of audiological evaluation and correlate it to the possible pathophysiological/radiological findings
- e) Apply the latest technological advances available for persons with hearing impairment.
- f) Make appropriate modifications in hearing devices depending on the listening needs.
- g) Recommend appropriate aural rehabilitation program for persons with hearing impairment

### **Demonstrate**

- a) Recording of exogenous and endogenous potentials
- b) Generation of stimuli for recording AEPs
- c) Analyze auditory evoked potential waveforms
- d) Electroacoustic measurement of different types of hearing aids
- e) Carry out ear mold modifications

### **Do**

- a) Record OAEs, ABR for different stimuli and cortical auditory potentials on 5 persons with hearing loss
- b) Complete audiological evaluation on 5 persons with hearing loss and prepare a detailed report with appropriate recommendations
- c) Select and fit appropriate hearing devices to 10 individuals with different degree, configuration and type of hearing loss.
- d) Plan and carry out appropriate aural rehabilitation program for five children
- e) Evaluate and counsel/carry out appropriate audiological management for 5 persons with tinnitus.
- f) Carry out aided AEPs

### **Evaluation**

- a) Internal evaluation shall be based on attendance, clinical diary, log book and learning conference.
- b) External evaluation: Spot test, OSCE, Record, Viva-voce, case work



## Semester III

### A 301: Genetics of Hearing and Pediatric Audiology

Hours - 60 : Marks - 80

**Objectives:** After completing this course, the student will be able to

- a) understand the genetic basis for hearing loss
- b) understand the tests/procedures for identifying genes for hearing loss
- c) counsel parents or caregivers of children with genetic and non-genetic hearing loss
- d) carry out screening programs to identify hearing loss using appropriate protocols, and
- e) diagnose and manage hearing loss in children using appropriate tests/protocols and aural management procedures

#### Unit 1: Molecular Genetics for Audiologists

- Basic concepts of genetics
- Genes involved in hearing
- Gene localization methods, gene mapping

#### Unit 2: Genetic Hearing Loss

- Genetics of hearing impairment, gene database for hearing loss
- Genetic evaluation of persons/families with hearing loss, genetic screening
- Genotypes and phenotypes of non syndromic hearing loss
- Genotypes and phenotypes of syndromic hearing loss
- Genetic counseling

#### Unit 3: Hearing Screening

- Neonatal and infant hearing screening, international and national Protocols to identify middle ear disorders; sensory and neural hearing loss
- Screening for hearing loss in school children
- Screening for central auditory processing disorders in school children
- Issues related to hearing screening

#### Unit 4: Pediatric Hearing Evaluation

- Etiology of hearing loss in children
- Behavioral tests of hearing evaluation for children
- Physiological tests of hearing evaluation for children
- Assessing hearing in children with associated problems
- Speech audiometry in children
- Development of tests for speech audiometry in children
- Issues related to assessment and diagnosis of hearing loss in children

## **Unit 5: Team Approach in diagnosis of hearing loss in children**

- Integration of results of behavioral and electrophysiological assessment of hearing
- Correlating results of audiological evaluation with those of otolaryngological, pediatric, psychological and speech-language evaluation
- Problems faced by children with hearing loss in preschool and school setup
- Challenges/problems faced by children with conductive hearing loss and auditory processing problems
- Counseling parents/caregivers regarding hearing impairment, sequel and management
- Counseling and management of children with unilateral hearing loss and mild hearing loss

### **Recommended Reading**

- Bess, F.H. & Gravel, J.S. (2006). Foundations of Pediatric Audiology. San Diego: Plural Publishing Inc
- Driscoll, C. & McPherson, B (2010). Newborn Screening Systems: The complete perspective. San Diego: Plural Publishing Inc
- Martini, A, et al.(1996) Genetics and Hearing impairment, London: Whurr Publishers.
- McCreery, R.W. & Walker, E.A. (2017). Pediatric Amplification: Enhancing Auditory Access. San Diego: Plural Publishing Inc
- Northern, J. L. & Downs, M. P. (2014). Hearing in Children. San Diego: Plural Publishing Inc
- Shprintzen, R.J. (1997). Genetic, Syndromes and communication disorders. San Diego: Singular Publishing Group Inc.
- Willems P J. (2004). Genetic Hearing loss. USA: Marcel Decker Inc.
- Tharpe, A.M. & Seewald, R. (2016). Comprehensive Handbook of Pediatric Audiology. San Diego: Plural Publishing Inc
- Toriello H V., & Smith S D. (2013). Hereditary Hearing Loss and Its Syndromes. United Kingdom: Oxford University Press.
- Flexer C A (2008). Pediatric Audiology: Diagnosis, Technology, and Management. New York: Thieme Medical Publishers.

## **A 302: Electrophysiological Assessment**

Marks -80: Hours - 60

**Objectives:** After completing this course, the student will be able to

- a) describe and classify auditory evoked potentials,
- b) understand the technology for recording auditory evoked potentials,
- c) record and interpret exogenous and endogenous potentials,
- d) use appropriate protocols for recording exogenous and endogenous potentials for clinical and research purposes, and
- e) understand research needs in auditory evoked potentials

### **Unit 1: Foundations of Auditory Evoked Potentials (AEPs)**

- Introduction and Classification of AEPs
- Neuroanatomy and neurophysiology related to AEPs; dipole orientation and scalp distribution of AEPs
- Stimuli for recording AEPs- generation, characteristics and types
- Electrodes for recording AEPs
- General principles of recording AEPs
- Overview to advanced analyses techniques such as independent component and time frequency analyses
- Maintenance and Calibration of instrumentation

### **Unit 2: Auditory Brainstem Responses**

- Acquisition and analysis responses for different stimuli -clicks, tone bursts, chirps, complex stimuli such as speech
- New trends in ABR such as Cochlear Hydrops Analysis Masker Procedure (CHAMP) and stacked ABRs, and ABR for chained stimuli,
- Factors influencing ABR: Stimuli related, acquisition related, subject related
- Clinical applications

### **Unit 3: Middle Latency Auditory Evoked Potentials and Auditory Steady State Responses**

- Acquisition and analysis of middle latency responses,
- Factors influencing middle latency responses: Stimuli related, acquisition related, subject related
- Acquisition and analysis of auditory steady state responses (ASSR)
- Factors influencing ASSR: Stimuli related, acquisition related, subject related
- Post auricular muscle responses
- Clinical applications

#### **Unit 4: Cortical Auditory Evoked Potentials**

- Overview of exogenous and endogenous cortical evoked potentials
- Acquisition and analysis of obligatory cortical auditory evoked potentials, acoustic change complex, T-complex, mismatch negativity, P300, N400, P600, CNV and other endogenous potentials
- Factors affecting exogenous and endogenous evoked potentials Stimuli related, acquisition related, subject related
- Clinical applications

#### **Unit 5: Intraoperative monitoring**

- Physiological tests useful in intraoperative monitoring of auditory function
- Effect of anaesthetic agents on electrophysiological responses of the auditory system
- Recording auditory evoked potentials during surgery; requirements, patient preparation
- Guidelines for intraoperative monitoring
- Electroneurography

#### **Recommended Reading**

- Burkard, R.F., Don, M., & Eggermont, J.J. (Eds.) (2007). Auditory Evoked Potentials: Basic Principles & Applications. Baltimore: Lippincott Williams & Wilkins.
- Ferraro, J.A. (1997). Laboratory exercises in auditory evoked potentials. San Diego: Singular Publishing Group Inc.
- Hall, J.W. (1992). Handbook of Auditory Evoked Responses. Massachusetts: Allyn and Bacon.
- Hall, J.W. (2007). New Handbook of Auditory Evoked Responses. Boston: Pearson.
- Hall, J.W., & Mueller, H.G. (1997) Audiologists' Desk Reference. Volume 1: Diagnostic Audiology Principles, Procedures and Protocols. San Diego: Singular Publishing Group.
- Hood, L.J. (1998). Clinical applications of auditory brainstem response. San Diego: Singular Publishing Group Inc.
- Katz, J. (Ed.). (1994). Handbook of Clinical Audiology. Baltimore: Williams and Wilkins.
- Kilney, P.R. (2017). Audiologists handbook of intraoperative neurophysiological monitoring. San Diego: Plural Publishing Group
- McPherson, L.D. (1995). Late potentials of the auditory system. London: Singular Publishing Group.
- Picton, T. (2010). Human Auditory Evoked Potentials. San Diego: Plural Publishing Group.
- Rance, G (2008). Auditory Steady State Responses. San Diego: Plural Publishing Group

### **A303: Speech Perception**

#### **Objectives:**

- a) After completing this course, the candidate should be able to
- b) Explain coding of speech in the auditory pathway in normal hearing individuals
- c) Explain basic concepts regarding speech perception
- d) Critically evaluate theories of speech perception and methods to synthesis speech
- e) Describe the major and minor acoustic cues for speech perception in normal hearing individuals
- f) Explain about speech perception in relation to short term memory
- g) Describe aspects related to dichotic speech perception
- h) Explain infant and animal speech perception

#### **• Unit 1: Introduction to Speech Perception**

- Coding of speech in the auditory pathway
  - Coding in the cochlear and auditory nerve
  - Coding in the central pathway
- Normalization in speech perception
  - Definition
  - Methods used for normalization of vowels and consonants
- Categorical perception
  - Definition
  - Evidence for and against categorical and continuous speech perception
- Theories of speech perception
  - Acoustic theory
  - Neurological theory
  - Auditory theory
  - Motor theory
  - Analysis by synthesis

#### **• Unit 2: Speech Perception of Segmental and Suprasegmental Features**

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

- Major and minor cues to differentiate between Stops, Fricatives, Affricates, Nasals
- Acoustical parameters used to differentiate vowels from consonants
- Perception of suprasegmental cues in normal hearing individuals

- **Unit 3: Methods in studying speech perception**

- Methods used to study speech perception
  - Analysis by synthesis
  - Parametric synthesis
  - Articulatory synthesis
- Effects of co-articulation on speech perception:
  - Perception of vowels from consonantal segmental cues
  - Perception of consonants from vowel segmental cues

- **Unit 4: Factors related to speech perception**

- Short term memory and speech perception
  - Stages of memory and coding at the different stages
  - Theories of short term memory
  - Perception of consonants and vowels in short term memory
  - Differences in the perception of consonants and vowels in short term memory
- Dichotic listening
  - Theories
  - Factors affecting dichotic perception
  - Stimulus parameters
  - Procedure parameters
  - Subject parameters
  - Application in the field of speech and hearing

- **Unit 5: General issues related to speech perception**

- Infant perception
  - Methods of studying infant speech perception
  - Advantage of one method over the other
  - Theories of infant perception
  - Studies to support the theories
  - Perception of consonants and vowels in infants
  - Comparison of adult and infant perception
- Animal speech perception
  - Need to study animal speech Perception of consonants and vowels
  - Categorical perception
  - Animal Vs. human perception

## Recommended reading:

- Anisworth, W.A. (1976). Mechanism of speech recognition. International series in natural philosophy. Vol. 85, Oxford: Pergamon Press.
- Berlin, C. (1984). Hearing science. California: College-Hill Press, Inc.
- Border, G. J., & Harris, K. S. (1980). Speech sciences primer: physiology, acoustic and perception of speech. London: Williams and Wilkins.
- Kent, R. D. & Read, C. (1995). The acoustic analysis of speech. New Delhi: AITBS Publishers and distributors.
- Sanders, D.A (1977). Auditory perception of speech - an introduction to principle and problems. New Jersey: Prentice Hall.
  
- 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.
- Eggermont, J. J. (2001). Between sound and perception: reviewing the search for a neural code. Review, *Hearing Research*, 157(1-2), 1-42.
- Flanagan, Frisina, R. D. (2001). Subcortical neural coding mechanisms for auditory temporal processing. Review, *Hearing Research*, 158 (1-2), 1-27.
- Frank, E.M., & Jane, A.B. (1985). Neuroanatomy, Neurophysiology and Central auditory assessment, *Ear and Hearing*, 283-293.
- 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.
- [Schouten, M. E., & Van Hoesen, A. J.](#) (1992). Modeling phoneme perception. I: Categorical perception. *Journal of the Acoustical Society of America*, 92 (4), 1841-1855.
  
- [Strange, W.](#) (1989). Evolving theories of vowel perception.-Review. *Journal of the Acoustical Society of America*, 85 (5), 2081-2087.
  
- [Abramson, A. S., Nye, P. W., Henderson, J. B., & Marshall, C.W.](#) (1981). Vowel height and the perception of consonant nasality. *Journal of the Acoustical Society of America*, 70 (2), 329-339.
- [Behrens, S., & Blumstein, S. E.](#) (1988). On the role of the amplitude of the fricative noise in the perception of place of articulation in voiceless fricative consonants. *Journal of the Acoustical Society of America*, 84 (3), 861-7.
- [Fischer, R. M., & Ohde, R. N.](#) (1990). Spectral and duration properties of front vowels as cues to final stop-consonant voicing. *Journal of the Acoustical Society of America*, 88 (3), 1250-1259.
- Gopal, H.S. (1992). Model of speech perception: An auditory approach to vowel recognition. *Journal of Indian Speech and Hearing Association*. (9), 1-14.
- [Hogan, J. T., & Rozsypal, A. J.](#) (1980). Evaluation of vowel duration as a cue for the voicing distinction in the following word-final consonant. *Journal of the Acoustical Society of America*, 67 (5), 1764-1771.

- [Kewley-Port, D.](#) (1983). Time-varying features as correlates of place of articulation in stop consonants. *Journal of the Acoustic Society of America*, 73 (1), 322-335.
- [Kurowski, K., & Blumstein, S. E.](#) (1987). Acoustic properties for place of articulation in nasal consonants. *Journal of the Acoustic Society of America*, 81 (6), 1917-1927.
- [Stevens, K. N., & Blumstein, S. E.](#) (1978). Invariant cues for place of articulation in stop consonants. *Journal of the Acoustical Society of America*, 64 (5), 1358-1368.
- [Whalen, D. H.](#) (1981). Effects of vocalic formant transitions and vowel quality on the English [s]-[ʃ] boundary. *Journal of the Acoustical Society of America*, 69 (1), 275-282.
  
- [Beckman, M., & Shoji, A.](#) (1984). Spectral and perceptual evidence for CV coarticulation in devoiced /si/ and /syu/ in Japanese. *Phonetica*, 41 (2), 61-71.
- [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.
- [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
- [Gottfried, T. L., & Strange, W.](#) (1980). Identification of coarticulated vowels. *Journal of the Acoustical Society of America*, 68 (6), 1626-1635.
- [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.
- [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.
- [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.
- [Repp, B. H., & Mann, V. A.](#) (1981). Perceptual assessment of fricative--stop coarticulation. *Journal of the Acoustical Society of America*, 69 (4), 1154-1163.
- [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.
- 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.
- [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.
- David B. Pisoni (1973). Auditory and phonetic memory codes in the discrimination of consonants and vowels. *Perception & psychophysics*, 13 (2), 253-260.
- David, B. Pisoni (1979). Auditory short-term memory and vowel perception. *Memory & cognition*, 3(1) 7-18.



- Eilers & Morse (1981). Discrimination of VOT in infancy. *Journal of Acoustic Society of America*.
- [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.
- 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.
- [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.
- Rintelman. (1991). Hearing assessment. Allyn and Bacon. PRO-ED, Inc.
- Walley, Aslin & Pisoni (1984). Infant discrimination of 2 and 5 formant stop consonants differing in place of articulation. *Journal of Acoustic Society of America*.

## **A 304: Auditory Processing Disorders**

60 hours: 80 marks

**Objectives:** At the end of the course, the students should be able to

- a) Diagnose and differentially diagnose auditory processing disorders (apds) and explain their physiological bases,
- b) Administer different tests for diagnosis and interpret the findings including correlation with findings from imaging and cognitive studies,
- c) Institute screening and public education programs in different setups on apds,
- d) Identify and explain factors influencing assessment of apds,
- e) Advise clinical clientele on management of APDS including guidance on aids and appliances, and
- f) Advise and liaise with members of the management team like neurologists, neurosurgeons on the diagnosis as well as management of apds.

### **Unit 1: Introduction to Auditory Processing Disorders (APDs)**

- Terminologies and definitions of APD
- Underlying neurobiological and neurochemical (genetic) correlates
- Relationship between neural maturation - degeneration and auditory processing
- Models to explain auditory and spoken language processing: Relationship between the two
- Methods of studying auditory processing - Animal studies
- Various disorders that lead to APDs ( Syndromes, TBIetc): Signs, symptoms and classification
- Developmental communication disorders and APDs

### **Unit 2: Assessment of APDs (Behavioral)**

- Overview of behavioral assessment in APDs
- Screening for APDs: questionnaires, checklists and tests
- Dichotic test (linguistic and non-linguistic)
- Monaural tests (linguistic and non-linguistic)
- Psychoacoustic tests for assessment of APDs

### **Unit 3: Assessment of APDs (Electrophysiological)**

- Electrophysiological measures and their clinical applications in diagnosing APDs
- Endogenous potentials
- Exogenous potentials
- Correlation between behavioral and electrophysiological measures: implications for diagnosis
- Factors influencing assessment of APDs: behavioral and electrophysiological

### **Unit 4: Management of APDs**

- Management of APDs in children and adults
- Direct remediation techniques and meta-cognitive and meta-linguistic approaches

- Auditory perceptual training and its methods, applicability and outcome.
- Evidence based approach and treatment efficacy
- Multidisciplinary approach
- Signal enhancement and room acoustics
- Aids and appliances - indication and outcome
- Factors affecting management of APDs

### **Unit 5: Team work in the diagnosis and management of APDs**

- Electrophysiological and radiological correlates for APDs: implications in management
- Imaging and cognitive studies in APDs
- Diagnosis and differential diagnosis
- Development of APD test materials (linguistic and non-linguistic)
- Open source software for developing diagnostic tests and intervention modules

### **Recommended Reading**

- American Speech-Language-Hearing Association. (2005). (Central) auditory processing disorder (technical report) Retrieved from <http://www.asha.org/members/desref-journals/deskref/default>.
- Geffner, D., & Ross-Swain, D. (2013). Auditory Processing Disorders: Assessment, Management, and Treatment. 2nd Edn. San Diego, Plural Publishing Inc.
- Musiek, F. E., Baran, J. A., Shinn, J. B., & Jones, R. O. (2012). Disorders of the Auditory System. San Diego: Plural Publishing Inc.
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- 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.
- Chermak, G. D., &Musiek, F. E. (2006). Handbook of (Central) Auditory Processing Disorders – Comprehensive Intervention. Vol. II. San Diego: Singular Publishing Group Inc.
- 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.

## **A 305: Vestibular System and its Disorders**

60 hours: 100  
marks

**Objectives:** After completing this course, the student should be able to

- Describe the functioning of the balance and vestibular system
- Explain the disorders of the vestibular system
- Assess vestibular system using appropriate tests/protocols
- Recommend appropriate management option for persons with vestibular dysfunction
- Counsel and guide the clinical clientele with vestibular disorders on quality of life etc.

### **Unit 1: Anatomy and Physiology of the Vestibular System**

- Peripheral vestibular system including semicircular canals, utricle, saccule and vestibular nerve
- Central vestibular pathway (brainstem, cerebellum, cortex)
- Reflexes involving vestibular system like vestibuloocularreflex, vestibulo spinal reflex and vestibulo colic reflexadvise
- Other systems involved in maintenance of balance like proprioceptive system, visual system etc.

### **Unit 2: Assessment of the Vestibular System**

- Techniques and Principles of electronystagmography / videonystagmography, Rotatory chair test, Video Head Impulse test, Sclera Coil search test, Vestibular Evoked Myogenic Potentials: cVEMP, oVEMP, Dynamic Posturography, Craniocorpography, Subjective visual vertical horizontal tests, Vestibular autorotation tests
- Screening for vestibular disorders
- Questionnaires to assess quality of life in persons with vertigo

### **Unit 3: Pathophysiology of Vestibular Disorders**

- Peripheral Vestibular Disorders like Benign paroxysmal positional vertigo, Meniere's disease, Vestibular neuritis, Labyrinthitis, Ototoxicity, vestibular neuropathy
- Perilymph fistula, Superior semicircular canal dehiscence, Auditory neuropathy spectrum disorders, Vestibular schwannomas
- Central Vestibular disorders like Generalized neuropathy involving multiple systems, Multiple sclerosis, Cranial tumors, Cerebro-vascular accidents involving vestibular cortex and cerebellum, Vertebro-basilar insufficiency, Migraine, Meningitis and encephalitis
- Vestibular disorders in children
- Age related changes in vestibular system

### **Unit 4: Profiling Vestibular Disorders using Audio Vestibular Test Battery**

- Benign paroxysmal positional vertigo, Meniere's disease, Vestibular neuritis, Labyrinthitis, Ototoxicity, Perilymph fistula, Superior semicircular canal dehiscence,

Auditory neuropathy spectrum disorders, Vestibular schwannomas, Multiple sclerosis, Cranial tumors, , vestibular neuropathy

- Quality of life in persons with vestibular disorders

### **Unit 5: Management of Persons with Vestibular Disorders**

- Medical management
- Surgical management
- Vestibular rehabilitation:
- Repositioning Maneuvers
- Adaptation Exercises
- Habituation Exercises
- Imbalance Exercises
- Special considerations for rehabilitation of children with vestibular problems
- Vestibular implants

### **Recommended Reading**

- Ackley, R. S., Decker, T. N., & Limb, C. J. (2007). An essential guide to hearing and balance disorders. New Jersey: Lawrence Erlbaum Associates Inc.
- Biswas, A. (2009). Clinical audio-vestibulometry for otologists and neurologists. 4<sup>th</sup> Ed. Mumbai, India: Bhalani Publishing House.
- Desmond, A. L. (2004). Vestibular function: evaluation and treatment. New York: Thieme Medical Publishers Inc.
- Hughes, G. B., & Pensak, M. L. (2007). Clinical Otology. New York: Thieme Publishers, Inc.
- Jackler, R. K., & Brackmann, D. E. (2005). Neurotology. 2<sup>nd</sup> Ed. Philadelphia: Elsevier Mosby.
- Jacobson, G. P., & Shepard, N. T. (2014). Balance function assessment and management. San Diego: CA: Plural Publishing Inc.
- Kaga, K. (2014). Vertigo and balance disorders in children. Tokyo, Japan: Springer.
- McCaslin, D. L. (2013). Electronystagmography and videonystagmography ENG / VNG. San Diego: Plural Publishing Inc.
- Murofushi, T., & Kaga, K. (2009). Vestibular evoked myogenic potential- its basics and clinical applications. Tokyo, Japan: Springer.
- Myers, B.L. (2011). Vestibular Learning Manual. San Diego: Plural Publishing Inc.
- O'Reille, R.C., Morlet, T & Kushing, S.L (2013). Manual of pediatric balance disorders. San Diego: Plural Publishing Inc.
- Ruckienstien, M & Davis, S. (2014). Rapid interpretation of balance function tests. San Diego: Plural Publishing Inc.
- Shepard, N. T., & Telian, S. A. (1997). Practical management of the balance disorders patient. New York: Thomson Delmar Learning.

## **A 401: Audiology in Practice**

Marks - 80 : Hours - 60

**Objectives:** At the end of the course, the students should be able

- a) Know the role of an audiologist in different set-ups.
- b) Liaise with other professionals in setting-up an audiology clinic.
- c) Audit audiology practices in existing set-ups.
- d) Implement acts and legislations relating to persons with hearing impairment,
- e) Advise Governments and other agencies on the formulation of policies and legislative acts relating to hearing disability
- f) Understand the legal implications of practice in audiology.

### **Unit 1: Scope of Practice, Laws, Regulations and Professional Ethics**

- Scope of practice in global and Indian scenario
- Professional ethics.
- Existing acts, legislations, policies related to persons with communication impairment
- Role of audiologist in the formulation of acts, regulations and policies
- Implementation of acts, legislations, policies and welfare measures relating to persons with hearing impairment
- Advocacy groups and rights of citizens
- National and international standards related to audiology
- Welfare measures provided by State and Central Government for persons with hearing impairment

### **Unit 2: Specialized Programs in Audiology**

- Need for specialized programs in audiology: Geriatric and persons with multiple disability
- Forensic audiology
- Health, wellness, and health care - Health promotion and disease prevention, quality of life and healthcare finances
- Disability-friendly environment including public education
- Prevention and early identification programs including societal participation

### **Unit 3: Service Delivery Models in Audiology**

- Services in different medical / rehabilitation/ research /educational set ups
- School based services pertaining to regular and special schools
- Community based practice in rural and urban areas
- Family empowerment programs
- Home based delivery of services
- Autonomous practice in audiology
- Apps for hearing screening/assessment

### **Unit 4: Tele-practice in Audiology**

- Information and communication technology in Audiology practice

- Infrastructure for video-conferencing and tele-practice in audiology
- Techniques/principles of remote testing for screening and diagnostic assessment for hearing, intervention and counseling
- Challenges and limitations of tele-practice in audiology in screening, assessment and evaluation, selection of aids and appliances, therapeutics and counseling.

### **Unit 5: Issues in Audiology Practice**

- Medico-legal issues,
- Entrepreneurship and planning to set up private practice/clinic for audiology practice:
- Documentation in audiology practice: clinical / demographic data, database management and storage
- ICF framework for documentation / reports
- Quality control and auditing in audiology practice
- Documenting and implementing evidence based practice in audiology
- Understanding team approach: Work in cohesion with other professionals
- Information resources in audiology including books and journals, both electronic and print - Databases

### **Recommended Reading**

- College of Audiologists and Speech-Language Pathologists of Ontario.(2004). Use of Telepractice Approaches in Providing Services to Patients/Clients.
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- [www.rehabcouncil.nic.in](http://www.rehabcouncil.nic.in) (website of Rehabilitation Council of India)
- [www.disabilityaffairs.gov.in](http://www.disabilityaffairs.gov.in) (website of Department of Empowerment with Disabilities)
- Acts relating to disability, particularly hearing, enacted by the Indian Parliament

## **A 402: Implantable Auditory Devices**

Hours - 60: Marks - 80

**Objectives:** At the end of the course, the student should be able to

- a) Identify and describe the types of implantable hearing devices,
- b) Describe the purpose of different components of implantable hearing devices,
- c) Determine candidacy for implantable hearing devices,
- d) Assess benefits from implantable hearing devices and guide the clinical population, and
- e) Understand and contribute to formulation Government policies and schemes relating to implantable hearing devices

### **Unit 1: Development of Technology, Criteria/ Candidacy and Program**

- Candidacy for bone conduction implantable devices (BCID), middle ear implants (MEI), cochlear implant (CI), auditory brainstem implant (ABI) and mid brain implant (MBI): evidence from research
- Comprehensive Candidacy Assessment for implantable hearing devices (IHD- Audiological and non-audiological).
- Safety standards and regulation for IHD.
- State and central Government schemes for cochlear implants and other implantable devices.
- Pre-requisite to start aIHD program
- Comprehensive policy issues relating to IHD

### **Unit2: Bone Conduction Implantable Devicesand Middle Ear Implants**

- Types of BCID and components (per-cutaneous, trans-cutaneous and intra-oral)
- Types of MEI and components
- Intra-operative and post-operative measurements/assessment for device function (troubleshooting) and performance outcomes
- Programming BCID and MEI
- Contra indications and management of device failures and poor performance.
- Limitations and future development/requirement

### **Unit 3: Cochlear Implants**

- Concepts and types of ci : external components (sound processor- body worn, BTE, off the ear); internal component ( electrode type/design, MRI compatibility & reliability);totally implantable cochlear implants.
- Expanding criteria- audiological and non-audiological assessment: single sided deafness, ski sloping SN hearing loss, bilateral asymmetric HL; cochlea/nerve anomaly(classification), auditory neuropathy spectrum disorder (ANSD) and multiple disabilities.
- Speech/Sound Coding Strategies: Within and across devices; Evidences from research and critical analysis of each strategy; Features for Enhancing Speech and Music perception.
- Surgical procedures: posterior tympanotomy, varia technique, hearing preservation technique; surgical complications and management



- Intra-operative measurement: device function (impedance/ voltage/ compliance telemetry); patient function (eCAP, eSRT, eABR and facial nerve monitoring); Special consideration in anomalous cochlear/nerve, ANSD and multiple disabilities.

#### **Unit 4: Programming Cochlear Implants**

- Psychophysics of programming: parameters (pulse width, rate of stimulation,
  - frequency allocation/ re-allocation, map law);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); special considerations in cochlea/nerve anomaly, ANSD, multiple disabilities and SSD; Effect of map parameters on perception of loudness, pitch perception, gap,
- Programming technique: evidences from research: behavioral maps; objective maps (eCAP, eSRT&eABR based programming); evidence and target based programming (artificial intelligence);self-programming.
- Measuring performance and MAP optimization: assessment of benefit: speech and non-speech; electrophysiological measures (EABR and other evoked potentials); optimization of: hearing aid in the contralateral ear for bimodal implants; bilateral cochlear implants; electroacoustic stimulation and SSD.
- Complications: identifying and managing device failures; identifying and managing infection, magnet migration, electrode extrusion; identifying and managing poor performance; decision making in subjects with poor performance; special consideration in revision implantation; outcome audit.
- Limitations and future developments/requirements (device, techniques and procedures)

#### **Unit 5: Auditory Brainstem Implant (ABI) and Auditory Midbrain Implant (MBI)**

- Pre-op (ABI and MBI): candidacy for children and adult; audiological and non-audiological assessment; evidences from research for predicting outcome; counseling and expectations; device type and components
- Intra-op (ABI and MBI): Surgical procedures – overview; eABR, cranial nerve monitoring; decision making.
- Post-op: programming ABI (subjective and objective methods) and technique for pitch ranking, identifying auditory and non-auditory electrodes); MAP optimization (pitch, loudness, auditory and non-auditory sensation); techniques to identify auditory and non-auditory sensation; assessment of benefit: speech and non-speech; role of eABR, aided cortical potentials, PET and fNIRS in programming and monitoring outcomes.
- Managing and monitoring subject with ABI: rehabilitation strategy; identifying and managing complications (device failure, infection, trauma, device migration, radio imaging); identify poor performance- auditing outcome; decision making in complications and poor performance

#### **Recommended Reading**

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## **A 403: Speech Perception in Clinical Population**

### **Objectives:**

- a) After completing this course, the candidate should be able to
- b) Explain about speech perception in individuals with different configurations, types, degrees of hearing impairment
- c) Differentiate / compare perception of speech through different senses and listening devices
- d) Critically examine different methods to evaluate speech intelligibility, and describe the factors effecting speech intelligibility
- e) Apply information on speech intelligibility / speech perception in the field of speech and hearing

### **Unit 1: Peceptual cues for vowels and consonants**

- Perception of vowels, semivowels, and diphthongs in individuals with hearingimpairment
- Perception of consonants in individuals with a hearing impairment
- Effect of type, degree and audiogram configuration in perception of vowels and consonants

### **Unit 2: Perception of coarticulation and supra segmental features**

- 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
- Perception of suprasegmental cues in individuals with hearing impairment:
  - Perception of stress,
  - Perception of rhythm
  - Perception of intonation
- Perception of speech through the visual modality
- Perception of segmental and suprasegmental cues
- Perception of speech through the tactile modality
- Perception of segmental and suprasegmental cues

### **Unit 3: Speech perception through Hearing devices**

#### Perception of speech through cochlea implants

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

### Perception through multi-channel cochlear implants

- Vowels perception
- Consonants perception
- Speech identification scores
- Suprasegmental cues
- Effect of coding strategy on speech perception
- Effect of implant model on speech perception
- Speech perception through auditory brain-stem implants

### 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

### Comparison of speech perception through different devices/modalities

- Hearing aids vs. cochlear implants
- Hearing aids vs. tactile devices
- Cochlear implants vs. tactile devices
- Tactile vs. visual perception

## **UNIT 4: Speech intelligibility**

### Methods:

- 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

### Application of speech intelligibility

- In the area of evaluation
- In the area of rehabilitation
- In the area of research

### 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

#### UNIT 5: Application of speech perception in:

- Evaluation of the hearing impaired
- Rehabilitation of the hearing impaired
- Research regarding the hearing impaired

#### Recommended readings

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- 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.
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## **A 306 & A 405 Clinicals in Audiology**

### **General considerations**

- a) The student should be able to carry out complete audiological evaluation and management of persons with hearing impairment.
- b) After completion of clinical postings, the student will have the ability to apply, show (in a clinical diary/log book), and perform the following on patients/clients:

### **Know-how**

- Identify, manage and counsel persons with genetic hearing loss
- Choose/modify appropriate tests/protocols for evaluating children and multiply disabled
- Choose appropriate tests/protocols for evaluation and management of persons with giddiness
- Develop language / culture sensitive APD tests
- Advise clinical clientele on the latest implantable devices available for persons with hearing impairment.
- Set up audiology clinics / centers in different set ups
- Procedure for certification of persons with disability
- Financial planning and insurance policies

### **Demonstrate**

- Administration of different tests for APD
- Plan management for 5 persons with APD/at risk for APD
- Administration of different tests for vestibular assessment
- Troubleshoot cochlear implants

### **Do**

- Administer complete audiological test battery, behavioural and electrophysiological tests on 10 children with hearing loss and prepare a report explaining the results of the test and make appropriate recommendations
- Administer APD test battery on 5 persons with APD symptoms and prepare a report
- Administer complete vestibular test battery on 5 persons with giddiness
- Carry out pre-implant counselling for 5 persons with hearing loss
- Carry out mapping for 5 persons using cochlear implants
- Counsel 5 persons regarding use and maintenance of cochlear implants

### **Evaluation**

- Internal evaluation shall be based on attendance, clinical diary, log book and learning conference.
- External evaluation: Spot test, OSCE, Record, Viva-voce, case work



## **Recommended journals**

- Journal of Acoustical Society of America
- Acta Otolaryngologica
- Science
- Hearing Research
- Ear and Hearing
- Neuroimage
- Journal of Speech, Language and Hearing Research
- Journal of Indian Speech and Hearing Association
- Phonetica
- Perceptual Psychophysics
- Perception & psychophysics
- Memory & cognition
- American Journal of Audiology
- Journal of the American Academy of Audiology
- Seminar in Hearing
- International Journal of Pediatric Otorhinolaryngology
- Archives of Disability in Children
- British Journal of Audiology
- Audiology and Neurotology
- Audicibel