symbols for consonants made with different airstream mechanisms (clicks, voiced implosives, and ejectives). All these descriptions reflect the potentialities of human speech sounds (as a linguistic community) not only showing the possible segments but also the suprasegmental features and points related to the possible airstream mechanisms and even the diacritics for various types coarticulations and secondary articulatory gestures. The IPA chart is carefully documented (by experts) and is continuously revised and updated.

Lesson-33
LINGUISTIC PHONETICS-II

Topic-166: Feature Hierarchy

Feature hierarchy is an important concept in phonetics and phonology which is based on the properties and features of sounds. In a very general sense, a feature may be tied to a particular articulatory maneuver or acoustic property.

Sounds are divided in terms of their supra-laryngeal and laryngeal characteristics, and their airstream mechanism. The supra-laryngeal characteristics can be further divided into those for place (of articulation), manner (of articulation), the possibility of nasality, and the possibility of being lateral. Thus, these features are used for classifying speech sounds and describing them formally.

Topic-167: Feature Hierarchy: Discussion

For dividing speech sounds through feature hierarchy, the first division is made on the basis of the major regions of the vocal tract, giving us the five features in total (i.e., Labial, Coronal, Dorsal, Radical, and Glottal). The first three of these features are related to tongue position whereas 'Radical' is a cover term for [pharyngeal] and [epiglottal] articulations made with the root of the tongue. The feature of 'Glottal', on the other hand, is based on being [glottal], to cover various articulations such as [h]. If we are to have a convenient grouping of the features for consonants, we have to recognize that SupraLaryngeal features must allow for the dual nature of the actions of the larynx and include Glottal as a place of articulation. Remember that a sound may be articulated at more than one of the regions Labial, Coronal, Dorsal, Radical, and Glottal. Within the five general regions, '**Coronal' articulations can be split into three mutually exclusive possibilities**: Laminal (i.e., blade of the tongue), Apical (i.e., tip of the tongue), and Sub-apical (i.e., the under part of the blade of the tongue). Thus the major regions may be subdivided into sub regions on the basis of their features.

Lesson-34
LINGUISTIC PHONETICS-III

Topic-172: Memory for Speech

Speech is quite diverse and complex particularly when it comes to the phonetics of individual. It is understandable that different speakers of the same language will have somewhat different productions of speech depending upon their vocal tract physiology and their own habits of speech motor coordination and more importantly due to their memory of speech. Sociolinguistic features also influence; we are exposed to a

variety of speech styles ranging from very careful pronunciations in various types of public speaking to the quite casual style that is typical between friends. All this leads to the lack of phonetic invariants (or the variability of invariability). This 'lack of phonetic invariance' provides us with many reasonable justifications as it has posed an important problem for phonetic theory as we try to reconcile the fact that shared phonetic knowledge can be described using the IPA symbols and phonological features with the fact that the individual phonetic forms that speakers produce and hear on a daily basis span a very great range (of varieties). This lack of invariance as a problem also has great practical significance for language engineers who try to get computers to produce and recognize speech.

Topic-173: Explaining Memory for Speech

- **Language universal features**: Broad phonetic classes (e.g., aspirated vs. unaspirated) derive from physiological constraints on speaking or hearing, but their detailed phonetic definitions are arbitrary—a matter of community norms.
- **Speaking styles**: No one style is basic (from which others are derived), because all are stored in memory. Bilingual speakers store two systems.
- **Generalization and productivity**: Exemplar theory says that generalization is also possible within productivity. Interestingly, productivity—the hallmark of linguistic knowledge in the phonetic implementation approach—is the least developed aspect of the exemplar theory.
- **Sound change**: Sound change is phonetically gradual and operates across the whole lexicon. It is a gradual shift as new instances keep on adding.

Topic-174: The Balance Between Phonetic Forces

In order to explain the sound patterns of a language, the views of both speaker and listener are considered. Both of them like to use the least possible articulatory effort (except when they are trying to produce very clear speech), and there are a large number of assimilations, with some segments left out, and other reduced to minimum. Thus a speaker uses language with an ease of articulation (e.g., coarticulation and secondary articulation). This tendency to use language sounds with maximum possible ease of articulation leads to change in the pronunciation of words.

Lesson-35
PHONOTACTICS AND SYLLABIC TEMPLATES

Topic-177: Explaining Syllabification

Consonant sequences are called clusters (e.g., CC – two consonants or CCC – three consonants). Most of the phonotactic analyses are based on the syllable structures and syllabic templates.

Topic-178: Phonotactics

The study of the phonemes and their order found in the syllables (the study of sound sequences) of a language is called the phonotactics. It has often been found that languages do not allow all phonemes to appear in any order (e.g., a native speaker of English can figure out fairly easily that the sequence of phonemes /streŋθs/ makes an English word ('strengths') and that the sequence /bleidg/ would be acceptable as an English word

'blage', although that word does not happen to exist, but the sequence /lvm/ could not possibly be the part of an English word). Phonotactic analyses of English come up with some interesting findings. For example, why should 'bump', 'lump', 'hump', 'rump', 'mump(s)', 'clump' and others all be associated with large blunt shapes? Why should there be a whole family of words ending with a plosive and a syllabic /l/ all having meanings to do with clumsy, awkward or difficult action (e.g., 'muddle', 'fumble', 'straddle', 'cuddle', 'fiddle', 'buckle', 'struggle', 'wriggle')? Why can't English syllables begin with /pw/, /bw/, /tl/, /dl/ when /pl/, /bl/, /tw/, /dw/ are acceptable? All such discussion is called the phonotactics of the language.

Topic-179: Explaining Phonotactics

Phonotactics is a term used in phonology to refer to the order (sequential arrangements or tactic behavior) of segments (sounds or phonological units) which occur in a language. It shows us what counts as a phonologically well-formed structure of a word. The allowed sound patterns and restricted sound patterns of language are found through phonotactics. For example, in English, consonant sequences such as /fs/ and /spm/ do not occur initially in an English word, and there are many other restrictions on the possible consonant+vowel combinations which may occur. By thoroughly analyzing the data, the 'sequential constraints' of a language can be stated in terms of phonotactic rules. According to the Generative phonotactics, no phonological principles can refer to morphological structure; and phonological patterns which are sensitive to morphology (e.g. affixation, etc.) are represented only in the morphological component of the grammar (not in the phonology). Some examples from the English phonotactics are given for your understanding:

One phoneme pattern	V	I, oh, owe
Two phoneme pattern	CV	to, be, see
Three phoneme pattern	CVC	cat, dog, run
Four phoneme pattern	CCVC	stick, click, brick
Five phoneme pattern	CCVCC	brisk, treats, speaks
Six phoneme pattern	CCCVCC	streets, strand, strips
Seven phoneme pattern	CCCVCCC	strengths

Also possible: CCV (try) CCCVC (stroke), CCCV (straw), VCC (eggs) CVCC (risk), CVCCC (risks).

Lesson-36
USING PRAAT-1

Topic-180: Introduction to PRAAT

Praat is a computer program with which you can analyze, synthesize, and manipulate speech, and create high-quality pictures for your articles and thesis. You are advised to start going through the tutorial from its homepage.

Topic-183: Recording and Displaying

- Go to NEW > RECORD mono-sound (with sampling rate – 44100 Hz)
- Make sure the volume bar is fluctuating as you record – if it isn't, you're not recording; if you don't see the volume bar at all, you're not speaking loudly enough.
- Watch out for clipping. If your recording level is too high and you go into the red on the volume bar, you'll end up with what is called a "clipped" signal; this is very bad for speech analysis!
- Give the recording a name (in the box below "Save to list").
- Save to list.

Topic-184: Segmenting and Labeling

1. **Create a textgrid**: • In the Praat Objects window, highlight the subject (required) file. • Annotate > To TextGrid. • Create two tiers (this will be enough for our purposes). Write 'word segment' (these are two tiers) on the cell named 'All tier names' on the small window.
2. **Open the sound file and textgrid together**: • Hold down Ctrl and click on each file to highlight them both. • Edit (in your display you should now see the waveform (top), the spectrogram (middle) and the textgrid (bottom) corresponding to your sound file).
3. **Segment the file**: • Place the cursor at the beginning of the name on the spectrogram/waveform; a boundary line will show up. • Click in the little circle at the top of the word tier in the Textgrid to create a boundary. • To remove a boundary that you have made - Highlight the boundary - Go to Boundary > Remove OR click Alt+backspace.
4. **Label the intervals**: • Select/highlight the target interval by clicking between two boundaries; the selected interval should go yellow. • To input or change the text in an interval, edit in the Textbox above the spectrogram. • Give name to each interval you create ([first name] or [last name]).

Lesson-37
USING PRAAT-II

Topic-187: Measuring the Fundamental Frequency

1) **Displaying the pitch track and allowing Praat to measure the pitch automatically:** • Display the pitch track: Pitch > Show pitch. • Place your cursor in the middle – a stable portion of the vowel. • Go to Pitch > Get pitch – a box will appear with the pitch value in it (note it down)
2) **Displaying the pitch track and measuring pitch manually:** • Display the pitch track - Pitch > Show pitch. • Click on the blue pitch track in the middle of the vowel. • A red horizontal bar should appear with the pitch value (in dark blue) on the right side of the window (take the measurement from here).
3) **By looking at the waveform (top of the display):** • Zoom into a small piece of the waveform in the middle of the vowel and measure the period by highlighting one complete cycle and noting the time associated with it (in the panel above the waveform).

Topic-188: Measuring the Harmonics

Display a narrow-band spectrogram:

- Go to: Spectrum > Spectrogram settings.

- Change the window length to 0.025s – the default window length is 0.005s (wide-band spectrogram) - this changes the spectrogram dramatically!
- Looking at each vowel, notice the grey horizontal bands: these correspond to harmonics. For each vowel, measure the frequencies of the first 3 harmonics (H1-H3) and the 10th harmonic (H10).
- Click on the center (horizontally) of each harmonic in the center of each vowel.
- A red horizontal bar should appear with the frequency value on the left side of the window in red.

Topic-189: Measuring the Formants

Formants are the overtone resonances. Acoustically, in order to plot vowels on chart, F1-F2 are very important. By now, we know that the narrow bands spectrograms are required for measuring harmonics whereas we need the wide bands for measuring the formants (which are the important characteristics of sonorant speech sounds – vowels). On spectrogram, formants are thick bands (darkness corresponds to loudness; i.e. the darkest harmonics are the ones that are the most amplified). These amplified harmonics form the formants that are characteristic of sonorant speech sounds. Now, let's measure the first and second formants (F1 and F2) from the middle of each vowel using the three techniques outlined below and note down your measurements:

Displaying the formants (red dots on the spectrogram) automatically:

- Display the formant track: Formant > Show formants.
- Place your cursor in the middle, stable portion of the vowel.
- Go to Formant > Formant listing: a box will appear with the time point at which the measurement was taken, and the first four formants.

Topic-190: Relationship Between Harmonics and Formants

Captured in the source-filter model of the speech, it is clear now (from the comparison of the two values – for formants and harmonics) that harmonic numbers are different for one type of sounds but the formants are the same. Actually, the relationship between the harmonics and the formants is captured in the source-filter model of speech production. The point is that harmonics are related to the laryngeal activity (source) and formants are the output of the vocal tract (filter).

Lesson-38
USING PRAAT-III

Topic-191: Vowel Properties

For exploring the acoustics of vowels in this session, we need to record vowels and explore their properties. The eight vowels from American English (given in your book (Chapter 8) are to be recorded for the purpose (by now, you should know how to record them). These vowels are: heed, hid, head, had, hod, hawed, hood and who'd. When you are done with the recording, get ready for measuring the following three things: intrinsic pitch, spectral make up (formants) and plotting them in excel sheet (and finally exporting them to your Word document). Now, record yourself saying the words. Take a quick look at your vowels in the Edit window, and

make sure you can clearly see the vowel formants. If you have trouble seeing them, you can go back to the previous labs and learn it again. While doing this, please make a note of it on your worksheet.

Topic-194. Plotting Vowels on Chart

Finally, we are at the last step related to spectral make-up of vowel sounds. We have already taken the measurement of the first two formants and we are going to plot those values on a chart using the Excel spreadsheet. By putting F1 and F2 in separate columns, write the formant values associated with different vowels (giving vowels in the first column, the difference between F2 and F1 in the second column and F1 in the third). After putting the data in Excel sheet, we will use the Scatter chart from the same spreadsheet. Further in order to make it corresponding with the required values for F1 and F2, we will reverse the values for both formants (on both axis – Y and X). Now the zero for both F1 and F2 is at the right corner. Watch the video and you will find how F1 is inversely related to the height of the vowel and the difference between F2 and F1 to the frontness of the vowels. Once completed, export the chart to your Word document and give it the number and title accordingly.

Lesson-39
USING PRAAT – IV

Topic-196: Nasal Formants

Formants for nasal sounds are also important for acoustic analysis. Measure the first three (F1, F2 and F3) formants of nasals from the file (use the already learnt way of measuring formants). Remember that nasals have very distinctive waveforms (different than that of vowels) as they have distinctive forms of anti-formants (bands of frequencies damped) and formant transition.

Topic-197: Glide and Their Formants

Glides are also the sonorants (vowel-like) sounds as they have similar patterns (have formants). Read from our recorded file and take the first three formants (F1, F2 and F3) from the middle of the sounds for glides (both for /w/ and /j/) and explore their acoustic correlates. Carefully judge the center of these sounds (the midpoint of [w] and [j]). Analyze that how similar is the formant structure of glides with vowels and nasals. Draw lines to indicate F1, F2, F3 and compare with vowels.

Lesson-40
USING PRAAT-V

Topic-198: Stop Voicing on Spectrograph

There are three important acoustic correlates of voicing in stops: the voice bar, VOT, and the duration of the preceding vowel. Record /apa/, /aba/, /ata/, /ada/, /apha/ and /atha/ and for each of the stops in the file, take the three measurements according to the following instructions: See the voicing or the voice bar by exploring features of stop. We can also explore the features related to the place of articulation (any bilabial feature for /p/ or /b/ in comparison with non-bilabial). Also check the duration of the preceding vowels.

Topic-199: Measuring Voice Onset Time (VOT)

To calculate the VOT: Record /apa/, /aba/ /ata/, /ada/, /apha/ and /atha/. Zoom in through your stop sounds so that you can analyze the patterns of the stop sounds and find the difference among the three types of VOT (negative, zero and positive). Measure the VOT of each stop and compare voiced/voiceless counterparts (p/b, t/d, k/g). Similarly, zoom in so that you can clearly see the stop closure followed by the beginning of the vowel. You can measure the time between the end of the stop closure (the beginning of the release burst) and the onset of voicing in the following vowel (the onset of regular pitch pulses in the waveform).

Lesson-41
FURTHER AREAS OF STUDY IN P&P

Topic-200: P&P Research as the Part of ELT

Phonetics and phonology is a very potential area for research to be carried out in Pakistani context. In applied phonology, many areas can be explored; for example, issues faced by Pakistani learners of English may be studied. Similarly, the pronunciation issues of Pakistani learners are potential area through which the difficulties faced by Pakistani students may be addressed. Also, researchers can explore and document the features of Pakistani English based on their phonological features in order to get the Pakistani variety of English recognized. Other problematic areas may also include: segmental and supra segmental features (such as stress placement, intonation patterns and syllabification and resyllabification of English words by Pakistani learners. Contrastive analysis (between English phonology and the sound systems of the regional languages of Pakistan (Urdu, Punjabi, Sindhi, Balochi and Pashto) can also be carried out by the researchers. We can also think about exploring the consonant clusters and interlanguage phonology from second language acquisition point of view. While focusing on ELT as the part of applied linguistics, studies may also be carried out on Pakistani variety of English (development of its corpora, deviation from the standard variety (RP), its specific features, etc.). Moreover, IPA resources and their application on ELT in Pakistani context can also be studied.

Topic-201: Current Trends in P&P Research

Pakistani regional languages are the part of the rich linguistic regions. (Himalaya Hindu Kush (HKH) region, one of the richest regions in the world linguistically and culturally) may be very potential area for research in the fields of areal and typological linguistics (description of linguistic features crosslinguistically). While working on Pakistani regional languages, one may apply for funding from international organizations (e.g., organization for endangered languages and UNISCO).

Topic-202: Distinctive Features

Three principles for feature analysis: contrastive function (how it is different), descriptive function (what it is) and classificatory function (based on broader classes of sounds). Features may also be studied further as a part of language universals and then their role as language specific sub sets.

Topic-203: Experimental Phonetics

In experimental phonetics and phonology, the studies of sounds include various latest experimental techniques and computer software that are used under carefully designed lab experimentation. It is an important aspect of the application of the latest technology by going beyond the simple acoustics and by working in sophisticated phonetic labs in order to discover the hidden aspects of human speech. For example, questions such as 'How speech is produced and processed?' are the focus of experimental phonetics (explore the speech chain as the beginning of experimental phonetics as mentioned in Chapter-20 by Peter Roach). The latest trends under experimental phonetics include brain functions in speech production and processing (by using the latest equipment – many special instruments such as x-ray techniques), speech errors, neurolinguistics and the topics related to the developments through computers – for speech analysis and synthesis.

Lesson-42
THE PEDAGOGY OF PHONETICS AND PHONOLOGY

Topic-206: Developing Relevant Material

Developing relevant material for the teaching of phonetics and phonology is an important task for aspiring teachers of English language. Remember the specific needs of ELT activities in your own context and explore already developed material available online from various sources (such as British Council and other teacher resource centers); however, you must also be able to develop your own material (as specifically required by your students). For example, you can develop your material related to the pronunciation teaching to the learners of English. You can incorporate material related to the IPA text – transcription of the audio (listening) based activities – by involving students on using dictionaries (ideally the phonetic dictionaries) in the classroom.

Topic-208: Making Research Accessible to Teachers

Good teachers are expected to be active researchers and therefore busy in updating themselves about the latest researches and teaching methodologies around the world. It is also a pedagogical challenge for teachers to keep themselves updated by exploring pedagogical and technological challenges for ELT experts (in their own contexts and internationally). For example, the aspects of Task Based Learning and Teaching (TBLT) as a golden method for second language acquisition (SLA) may be effective in Pakistani context if explored by ELT practitioners. Teachers as the agents of change and they must be reading research studies and carry out research by and explore their issues and solutions. A good way is to keep reading teachers' digests and journals and participate in the online discussions by teaching associations.

Topic-209: Facilitating Action Research

As already discussed, teachers are expected to facilitate action research which is the most rewarding and productive for their own profession. For example, the phonetics of phonological speech errors if explored and shared by teachers (by investigating their own practices) may lead to a very positive discussion in the academic circles (of research into ELT – SLA). Similarly, topics such as learners' performance and development (e.g., what do good speakers do?) may yield useful results for teachers' fraternity. Having said this, it is required from teachers (and student teachers) to facilitate action research related to reading/listening issues, English reading strategies (e.g., in primary schools) – (and their effectiveness), impact on pronunciation and many more. Research in the fields of phonetic theory and the description with phonological, typological and broader implication may also be included in phonetics and phonology specific action research.

More on ENG507

- **Tap**: Tap is up and down movement of the top of the tip of tongue. For example, pronouncing the middle sound in word 'pity' with typical American accent [ɾ]. It is very brief and is produced by a sharp upward throw of the tongue blade. In this sound, tongue makes a single tap against the alveolar ridge.
- **Flap**: Flap is front and back movement of tongue tip at the underside of tongue with curling behind. It is found in abundance in Indo-Aryan (IA) languages [ɽ]. Typical flap sounds found in IA languages is a retroflex sound and the examples are [ɽ], [ɖ] and [ɳ].
- **Trill**: In the production of trill the articulator is set in motion by the current of air [r]. It is a typical sound of Scottish English as in words like 'rye' and 'row'.
- **Bilabial**: This sound is made with two lips (for example, /p/ and /b/). The lips come together for these sounds.
- **Labiodental**: This sound is made when the lower lip is raised to touch the upper front teeth (for example, /f/ and /v/).
- **Dental:** This sound is made with the tongue tip or blade and upper front teeth. For example, say the words thigh, thy and you will find the first sound in each of these words to be dental.
- **Alveolar**: This sound is made with the tongue tip or blade and the alveolar ridge. You may pronounce words such as tie, die, nigh, sigh, zeal, lie using the tip of the tongue or the blade of the tongue for the first sound in each of these words (which are alveolar sounds).
- **Retroflex:** This sound is produced when the tongue tip curls against the back of the alveolar ridge. Many speakers of English do not use retroflex sounds at all but it is a common sound in Pakistani languages such as Urdu, Sindhi, Pashto, Balochi and Punjabi.
- **Palato-alveolar**: This sound is produced with the tongue blade and the back of the alveolar ridge (for example, first sound in each of words like shy, she, show)
- **Palatal:** This sound is produced with front of the tongue and the hard palate (such as the first sound in 'yes'.
- **Velar**: This sound is produced with back of the tongue and the soft palate (such as /k/ and /g/).