AMITY UNIVERSITY
UTTAR PRADESH

Course Title: Multimedia Signal Processing
Course Code: ECE704
Credit Units: 6
Level: PG

L	T	P/ S	SW/F W	TOTAL CREDIT UNITS
3	1	4	0	6

Course Objectives: This course covers the concepts of multimedia signal processing and coding. It covers Psychoacoustic Principles, Time Frequency Analysis and Coding. The objective of this course is to provide students with fundamental knowledge about various signal processing techniques applied to digital audio signals. All of these are essential to the understanding of the function of present day digital audio processing systems and form a strong foundation of the learning of newly developed digital devices/systems with applications to audio signals. This course also introduces basics of video processing.

Prerequisites: Signal & Systems, Digital Signal Processing

	Weightage (%)
Module I *Signal Processing Essentials*	**20%**
• Introduction, • Spectra of Analog Signals, • Review of Convolution and Filtering, • Uniform Sampling, • Discrete-Time Signal Processing, • Transforms for Discrete-Time Signals, • The Discrete and the Fast Fourier Transform, • The Discrete Cosine Transform. • Difference Equations and Digital Filters, • The Transfer and the Frequency Response Functions, Poles, Zeros, and Frequency Response	
Module II: *Time Frequency Analysis and Multi-resolution*	**20%**
• The Short-Time Fourier Transform, • Review of Multirate Signal Processing, , • Down-sampling by an Integer,	

• Up-sampling by an Integer, • Sampling Rate Changes by Non-integer Factors, • Continuous and Discrete wavelet transform,Computataion of CWT • Time and Frequency resolution, • Mathematical approach to wavelets, Wavelet synthesis	
Module III: *Audio Signal Processing*	**20%**
• LP-Based Source-System Modeling for Speech, • Short-Term Linear Prediction, • Long-Term Prediction, • ADPCM Using Linear Prediction, • Open-Loop Analysis-Synthesis Linear Prediction, • Analysis-by-Synthesis Linear Prediction, • Code-Excited Linear Prediction Algorithms, • Linear Prediction in Wideband Coding, • Wideband Speech Coding, Wideband Audio Coding.	
Module IV: *Psychoacoustic Principles and Audio Signal Processing*	**20%**
• Absolute Threshold of Hearing, • Critical Bands, • Simultaneous Masking, • Masking Asymmetry, and the Spread of Masking, • Noise-Masking-Tone, • Tone-Masking-Noise, • Noise-Masking-Noise, • Asymmetry of Masking, • Perceptual Entropy Example Codec Perceptual Model: ISO/IEC, (MPEG - 1) • Psychoacoustic Model, • Spectral Analysis and SPL Normalization, • Identification of Tonal and Noise Maskers, • Decimation and Reorganization of Maskers, • Calculation of Individual Masking Thresholds, • Calculation of Global Masking Thresholds, • Perceptual Bit Allocation	
Module V: *Video Processing*	**20%**
• Introduction to video processing. • Sampling of Video signals, • Filtering operations.	

• Optical flow, • General Methodologies, • Pixel Based Motion Estimation, • Block- Matching Algorithm, • Mesh based Motion Estimation, • Global Motion Estimation, • Region based Motion Estimation, • Application of motion estimation in Video coding	

Student Learning Outcomes:

After the course, the student –

- can design and implement algorithms for processing audio and speech signals using Matlab
- can take into account the properties of acoustic signals and human hearing in the design of audio signal processing systems.
- understands the speech production apparatus and its models
- can estimate the effect of the signal representations on sound quality.
- can explain the main principles of common audio signal processing operations (equalization, dynamic control, perceptual audio coding)

Pedagogy for Course Delivery:

The course would be covered under theory. In addition to assigning project–based learning, early exposure to hands-on design to enhance the motivation among the students. It incorporates designing of problems, analysis of solutions submitted by the students groups and how learning objectives were achieved. Continuous evaluation of the students would be covered under quiz, viva etc.

Laboratory Experiments:

1. Write a MATLAB program to load, display, and play back Audio files.
2. Handling Audio files in MATLAB.
   a. Read an audio file, its sampling rate and bits per sample.
   b. Write an audio file, at different sampling rates, at different bits per sample.
   c. Play an audio file at different sampling rates.
   d. Use of whos command to view the variables in the workspace.
3. Up-sampling and down-sampling of audio file and its effect in perceptual properties.
4. Fourier Transform and inverse Fourier Transform of Audio signals, plot of the spectrum of audio signals. Audio synthesis from a select number (subset) of FFT components.
5. For an audio signal, include a framing module in a program and set the frame size to 256 samples. Every frame should be read in a 256 × 1 real vector called. Compute the fast Fourier transform of this vector. Compute the magnitude of the complex vector S_{freq} and plot its magnitude in dB up to the fold-over frequency. This computation should be part of the frame-by-frame audio processing program.
6. Analysis of audio signals using Short-term Fourier Transform (STFT) in the Time-frequency domain.

7. Analysis of multi-resolution, wavelet decomposition and reconstruction of audio signals at different levels using different filters.
8. Write a program to plot the absolute threshold of hearing in quiet. Give a plot in terms of a linear Hz scale.
9. Power spectral density of different types of audio signals.
10. Insert and recover data from an audio signal using LSB coding method
11. Write a MATLAB program to load, display, and play back Video files.
12. Handling Video files in MATLAB.
    a Read an Video file, its sampling rate and bits per sample.
    b. Write an Video file, at different sampling rates, at different bits per sample.
13. Play an Video file at different sampling rates.

Assessment/ Examination Scheme:

Theory L/T (%)	**Lab/Practical (%)**	**Total**
66.67%	33.33%	100%

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment					**End Term Examination**
Components (Drop down)	Mid-Term Exam(CT)	**S/V/Q**	**HA**	Attendance(A)	
Weightage (%)	10%	8%	7%	5%	70%

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; A: Attendance

Lab Assessment (P):

Continuous Assessment/Internal Assessment					**End Term Examination**
Components (Drop down)	A	**PR**	**LR**	V	
Weightage (%)	5%	10%	10%	5%	70%

A: Attendance, PR- Performance, LR – Lab Record, V – Viva. EE- External Exam,

Text & References:

- Andreas Spanias, Ted Painter, Venkatraman Atti, Audio Signal Processing and Coding, A John Wiley & Sons. Udo Zölzer.
- Digital Audio Signal Processing, John Wiley and Sons.
- Video processing and communication – Yao Wang, Joem Ostermann and Ya–quin Zhang, PH Int.