F.M = 70   Time = 3 Hrs.
Answer any FIVE   questions. The questions are of equal value.

1.a) What are the critical differences between waveform approximating coders and parametric coders in speech coding techniques? Mention the names of few factors along with their contributions which influence the choice of specific speech coding algorithm.

b) Derive the expression of quantization error using non-uniform quantizer step sizes, and then relate SNR (signal-to-noise ratio) in term of binary codeword B bits for a uniform Quantizer.

$$(2+5)+(4+3)$$

2.

(a) What is mean by adaptive quantizer ? Draw the block diagram of a backward adaptive quantizer.

(b) Show that the main advantage of a differential quantizer over the non-differential one is due to the reduction in the speech dynamic range to be quantized. Show the block diagram of quantizer and de-quantizer of a forward adaptive differential quantizer.

c) Derive the mathematical expression of prediction gain of a differential quantizer with the first order normalized correlation coefficient.

$$(2+2) + (2+4) +4$$

3.(a) What is the critical difference between a scalar and vector quantizer ? Write down the two necessary conditions to be satisfied for optimality in codebook design.

(b) Write down the mathematical expressions of computation cost and storage required for both full search codebook and binary search codebook. Show mathematically that both computation and storage requirements reduce with an increase in the number of stages.

(c) Briefly highlight the role of gain shape codebook in vector quantization and derive mathematical expression how the shape is maximized.

$$(2 + 2)+(3+3) + 4$$

4.   a) Draw the block diagram of a source filter model of speech production. Show the detailed solution to LPC analysis using the autocorrelation method. What are the relative merits achieved in Lattice methods over autocorrelation and covariance method.

$$(2+10+2)$$

5) a) Given a digital picture, briefly explain with mathematical analysis how its gray values can be extended over the whole dynamic range.

b) Suggest a method that does simultaneously gray-level range compression and contrast enhancement in digital picture using illumination and reflectance components.

7+7

6 a) "Picture restoration is an ill-conditioned problem at best and a singular problem at worst"---explain. Suppose you have been given a large number of degraded pictures with signal (picture)-independent noise---how can you design an optimal filter in a minimum mean-square error (MMSE) sense to achieve an estimated picture of the original one? Extend this method that produces an optimal restoration of a particular picture.

(2+8+4)

7. Write short notes on any **two**
a) Logarithmic quantizer
b) Lattice Method as LPC analysis
c) Constrained least-square error restoration in digital picture

7x2=14