

items using the codes given below:

Assertion (A) : The asymptotic coding gain achievable with Ungerboeck codes increases with the number of states in the Convolutional encoder.

Reason (R) : Improvements in the order of 6dB require codes with a very large number of states.

- a) both A and R are individually true and R is the correct explanation of A b) both A and R are individually true but R is not the correct explanation of A
c) A is true but R is false d) A is false but R is true.

10. Convolutional codes for which a feed forward does not exist are called..... [K₁]
a) recursive systematic convolutional codes b) catastrophic convolutional codes
c) recursive convolutional codes d) systematic convolutional codes

PART B (10 x 2 = 20 Marks)

11. Illustrate the concept of memoryless channel. List two memoryless digital modulation methods. [K₃]
12. Draw the phase trellis for CPFSK with $h=1/2$. [K₂]
13. Compare and contrast band limited and power limited signaling schemes. [K₄]
14. Draw the structure of correlation receiver with N correlators. [K₂]
15. Relate multi-h CPM with constant h CPM. [K₁]
16. Express the union bound on probability of error of ML detection in terms of Q function. [K₂]
17. Compare soft decision decoding and hard decision decoding. [K₂]
18. Construct the generator matrix G for a (5,1) repetition code. [K₂]
19. Define rate-compatible punctured convolutional codes and cite examples for it. [K₂]
20. Calculate the asymptotic coding gain of the channel for the following two channels. [K₃]
i) Binary symmetric channel ii) Binary input AWGN channel

Consider a rate-1/2, constraint length-7 convolutional code with free distance $d_{\text{free}} = 10$ for the above calculation.

PART C (6 x 5 = 30 Marks)

21. Estimate the power spectral density of a digitally modulated signal with finite memory with necessary equations. [K₃]

22. A binary digital communication system employs the signals [K₃]
- $$s_0(t) = A \quad 0 \leq t \leq T$$
- $$s_1(t) = 0 \quad 0 \leq t \leq T$$
- for transmitting the information. This is called on-off signaling. The demodulator cross correlates the received signal $r(t)$ with $s(t)$ and samples the output of the correlator at $t+T$.
- i) Determine the optimum detector for an AWGN channel and the optimum threshold, assuming that the signals are equally probable.
- ii) Determine the probability of error as a function of the SNR. How does on-off signaling compare with antipodal signaling?

23. Determine the optimal detection rule for binary antipodal signaling and binary orthogonal signaling. [K₂]

24. Determine the states S_n of the binary CPM scheme and sketch the phase tree and state trellis. Given: modulation index $h = 3/4$ and a partial response pulse with $L = 2$. [K₃]

25. A (6,3) systematic linear block code encodes the information $x=(x_1,x_2,x_3)$ into codeword $c=(c_1,c_2,c_3,c_4,c_5,c_6)$, such that c_4 is a parity check on c_1 and c_2 , to make the overall parity even (i.e., $c_1 \text{ XOR } c_2 \text{ XOR } c_4=0$). Similarly c_5 is a parity check on c_2 and c_3 , and c_6 is a parity check on c_1 and c_3 . [K₃]
- i) Determine the generator matrix for this code.
- ii) Find the parity check matrix for this code.

26. Explain the principle of Turbo code with necessary block diagrams and equations. [K₃]

PART D (4 x 10 = 40 Marks)

27. Derive the probability of error for power limited signaling scheme. [K₂]

28. Examine the optimal detection of orthogonal and biorthogonal signals and derive their error probability. [K₃]

29. i) Construct the (7,4) linear code word for the generator polynomial $g(D) = 1+D^2+D^3$ for the message bits 1001 using systematic encoding rule. (5) [K₃]

- ii) Discuss about LDPC codes. (5) [K₂]

30. A convolutional code is described by [K₃]
- $$g_1 = [1 \ 0 \ 1], \quad g_2 = [1 \ 1 \ 1], \quad g_3 = [1 \ 1 \ 1]$$

- i) Draw the encoder circuit corresponding to this code. (2)

- ii) Draw the state-transition diagram of this code. (2)

- iii) Draw the trellis diagram for this code. (2)

- iv) Find the transfer function and the free distance of this code. (4)
