

SRM VALLIAMMAI ENGINEERING COLLEGE
(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF
ELECTRONICS AND COMMUNICATION ENGINEERING
QUESTION BANK



I SEMESTER
M.E. Communication Systems
CU3162 – MODERN DIGITAL COMMUNICATION SYSTEMS

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Prepared by

Dr. D. Judson, Professor/ECE

CU3162 – MODERN DIGITAL COMMUNICATION SYSTEMS

UNIT I - COHERENT AND NON-COHERENT COMMUNICATION

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation - Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK-BER Performance Analysis- Receiver Synchronization –Network Synchronization.

PART A

Q.No	Questions	Marks	CO	BT Level	Competence
1.	Define a coherent receiver.		CO1	BTL1	Remember
2.	What is meant by an optimum receiver in AWGN?		CO1	BTL1	Remember
3.	State the principle of IQ modulation.		CO1	BTL2	Understand
4.	What is IQ demodulation used for in a digital receiver?		CO1	BTL1	Remember
5.	Define a noncoherent receiver.		CO1	BTL1	Remember
6.	What is a random phase channel?		CO1	BTL2	Understand
7.	List the applications of MFSK receivers.		CO1	BTL1	Remember
8.	Differentiate Rayleigh fading and Rician fading channels.		CO1	BTL2	Understand
9.	What is a partially coherent receiver?		CO1	BTL1	Remember
10.	Define DPSK.		CO1	BTL1	Remember
11.	What is the difference between BPSK and DPSK?		CO1	BTL2	Understand
12.	Define M-PSK modulation.		CO1	BTL1	Remember
13.	What is M-DPSK?		CO1	BTL1	Remember
14.	State the significance of BER performance analysis.		CO1	BTL2	Understand
15.	What is receiver synchronization?		CO1	BTL1	Remember
16.	Define network synchronization.		CO1	BTL1	Remember
17.	Why is synchronization critical in coherent detection?		CO1	BTL2	Understand
18.	Mention two advantages of noncoherent detection over coherent detection.		CO1	BTL2	Understand
19.	State the matched filter concept used in optimum receiver design.		CO1	BTL2	Understand
20.	What is the role of a correlator in a coherent receiver?		CO1	BTL1	Remember
21.	What are partially coherent receiver. Give its role in wireless communication?		CO1	BTL1	Remember
22.	Compare DPSK and PSK.		CO1	BTL1	Remember
23.	State the matched filter concept properties used in receiver design.		CO1	BTL2	Understand
24.	How receiver synchronization is used for signal detection ?		CO1	BTL1	Remember

PART B

Q.No	Questions	Marks	CO	BT Level	Competence
1.	a) Derive the structure of the optimum receiver in AWGN using the correlation/matched filter approach.	(8)	CO1	BTL4	Analyze
	b) Explain how this receiver structure minimizes the probability of error.	(8)	CO1	BTL4	Analyze
2.	Explain IQ modulation and demodulation with a neat block diagram, describing the role of the local oscillators and low-pass filters.	(16)	CO1	BTL3	Apply
3.	Derive the BER expression for coherent BPSK detection in an AWGN channel and analyze the effect of SNR on the error performance.	(16)	CO1	BTL4	Analyze
4.	Explain the concept of noncoherent detection of FSK signals in a random phase channel, with the relevant decision statistic.	(16)	CO1	BTL3	Apply
5.	a) Describe the structure and operation of an MFSK receiver.	(8)	CO1	BTL4	Analyze
	b) Analyze the bandwidth–power trade-off in MFSK systems as M increases.	(8)	CO1	BTL4	Analyze
6.	Analyze the statistical characteristics of Rayleigh and Rician fading channels and compare their probability density functions.	(16)	CO1	BTL4	Analyze
7.	Explain the operation of a partially coherent receiver and derive its performance in the presence of carrier phase uncertainty.	(16)	CO1	BTL3	Apply
8.	Derive the expression for the BER performance of DPSK and compare it with coherent BPSK.	(16)	CO1	BTL4	Analyze
9.	Explain the generation and detection of M-ary PSK signals with the aid of signal constellation diagrams.	(16)	CO1	BTL3	Apply
10.	Analyze the BER performance of M-DPSK as a function of M and SNR, and compare it with M-PSK.	(16)	CO1	BTL4	Analyze
11.	a) Explain the need for receiver synchronization in a digital communication system.	(8)	CO1	BTL3	Apply
	b) Describe carrier synchronization and symbol timing recovery techniques.	(8)	CO1	BTL3	Apply
12.	Explain the concept and importance of network synchronization in a multi-node digital communication system.	(16)	CO1	BTL3	Apply
13.	Compare the performance of coherent and noncoherent detection techniques for binary and M-ary modulation schemes.	(16)	CO1	BTL4	Analyze
14.	For a wireless link operating over a Rician fading channel, analyze how the K-factor influences the choice between coherent and partially coherent receiver design.	(16)	CO1	BTL4	Analyze

15.	a) Explain the concept of quadrature (IQ) signal representation for modulated signals.	(8)	CO1	BTL4	Analyze
	b) Analyze the effect of IQ gain and phase imbalance on receiver performance.	(8)	CO1	BTL4	Analyze

UNIT II - EQUALIZATION TECHNIQUES

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

PART A

Q.No	Questions	Marks	CO	BT Level	Competence
1.	Define a band-limited channel.		CO2	BTL1	Remember
2.	What is intersymbol interference (ISI)?		CO2	BTL1	Remember
3.	State the Nyquist criterion for zero ISI.		CO2	BTL2	Understand
4.	What is controlled ISI?		CO2	BTL1	Remember
5.	Define partial response signalling.		CO2	BTL1	Remember
6.	What is the purpose of an equalizer in a digital communication receiver?		CO2	BTL2	Understand
7.	List the different types of equalization algorithms.		CO2	BTL1	Remember
8.	What is the basic principle of the Viterbi algorithm?		CO2	BTL2	Understand
9.	Define a linear equalizer.		CO2	BTL1	Remember
10.	What is a zero-forcing equalizer?		CO2	BTL1	Remember
11.	What is decision feedback equalization (DFE)?		CO2	BTL2	Understand
12.	State one advantage of DFE over a linear equalizer.		CO2	BTL2	Understand
13.	Define adaptive equalization.		CO2	BTL1	Remember
14.	What is the LMS algorithm used for in equalization?		CO2	BTL1	Remember
15.	Mention two applications of the Viterbi algorithm.		CO2	BTL2	Understand
16.	What is meant by an eye pattern in a digital communication system?		CO2	BTL1	Remember
17.	Why is raised-cosine pulse shaping used in band-limited channels?		CO2	BTL2	Understand
18.	What is the excess bandwidth (roll-off) factor?		CO2	BTL1	Remember
19.	State the difference between linear and nonlinear equalizers.		CO2	BTL2	Understand
20.	What is error propagation in a decision feedback equalizer?		CO2	BTL2	Understand
21.	Give the importance of raised-cosine pulse shaping in band-limited channels?		CO2	BTL2	Understand
22.	How LMS algorithm used in equalization?		CO2	BTL1	Remember
23.	State one advantage of DFE over nonlinear equalizer.		CO2	BTL2	Understand

24	What is controlled ISI? Give its significance.	CO2	BTL1	Remember	
PART B					
Q.No	Questions	Marks	CO	BT Level	Competence
1.	Derive the Nyquist criterion for distortionless (zero-ISI) baseband transmission and explain its significance.	(16)	CO2	BTL4	Analyze
2.	Explain the concept of controlled ISI and partial response signaling with duobinary signaling as an example.	(16)	CO2	BTL3	Apply
3.	a) Explain the working of a linear transversal equalizer.	(8)	CO2	BTL3	Apply
	b) Derive the condition for a zero-forcing equalizer.	(8)	CO2	BTL3	Apply
4.	Explain the Viterbi algorithm for maximum likelihood sequence estimation with a suitable trellis example.	(16)	CO2	BTL3	Apply
5.	Analyze the performance of decision feedback equalizers and explain how they reduce noise enhancement compared to linear equalizers.	(16)	CO2	BTL4	Analyze
6.	Explain the LMS adaptive equalization algorithm and derive its weight-update equation.	(16)	CO2	BTL3	Apply
7.	a) Compare the performance of zero-forcing and MMSE equalizers.	(8)	CO2	BTL4	Analyze
	b) Analyze the effect of channel noise on each.	(8)	CO2	BTL4	Analyze
8.	Design an adaptive equalizer for a channel with severe ISI and justify your choice of algorithm.	(16)	CO2	BTL3	Apply
9.	Analyze the convergence behaviour of the LMS and RLS adaptive algorithms and compare their computational complexity.	(16)	CO2	BTL4	Analyze
10.	Explain the operation and structure of a fractionally spaced equalizer and discuss its advantages.	(16)	CO2	BTL3	Apply
11.	Analyze the impact of error propagation in decision feedback equalizers and suggest methods to mitigate it.	(16)	CO2	BTL4	Analyze
12.	a) Explain the concept of an eye diagram and its use in evaluating ISI.	(8)	CO2	BTL4	Analyze
	b) Analyze how equalization improves eye opening.	(8)	CO2	BTL4	Analyze
13.	For a severely time-dispersive wireless channel, propose an equalization strategy combining linear and decision-feedback stages, and justify the design.	(16)	CO2	BTL3	Apply
14.	Analyze the trade-offs between equalizer complexity and performance for Viterbi equalization versus adaptive linear equalization.	(16)	CO2	BTL4	Analyze
15.	Explain adaptive equalization algorithms used for time-varying channels and analyze their tracking capability.	(16)	CO2	BTL4	Analyze

UNIT III - BLOCK CODED DIGITAL COMMUNICATION

Architecture and performance – Binary block codes; Orthogonal; Bi-orthogonal; Transorthogonal – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hamming; Golay; Cyclic; BCH; Reed – Solomon codes. Space time block codes.

PART A

Q.No	Questions	Marks	CO	BT Level	Competence
1.	Define channel coding.	2	CO3	BTL1	Remember
2.	State Shannon's channel coding theorem.	2	CO3	BTL2	Understand
3.	What is channel capacity?	2	CO3	BTL1	Remember
4.	Define a binary block code.	2	CO3	BTL1	Remember
5.	What is an orthogonal code?	2	CO3	BTL1	Remember
6.	Define a bi-orthogonal code.	2	CO3	BTL2	Understand
7.	What is a transorthogonal code?	2	CO3	BTL1	Remember
8.	Define a matched filter and state its purpose in a receiver.	2	CO3	BTL2	Understand
9.	What is spread spectrum communication?	2	CO3	BTL1	Remember
10.	State two advantages of spread spectrum systems.	2	CO3	BTL2	Understand
11.	Define a linear block code.	2	CO3	BTL1	Remember
12.	What is a Hamming code used for?	2	CO3	BTL1	Remember
13.	Define a Golay code.	2	CO3	BTL1	Remember
14.	What is a cyclic code?	2	CO3	BTL2	Understand
15.	Define a BCH code.	2	CO3	BTL1	Remember
16.	What are Reed-Solomon codes used for?	2	CO3	BTL1	Remember
17.	Define a space-time block code (STBC).	2	CO3	BTL1	Remember
18.	State the minimum distance property of a linear block code.	2	CO3	BTL2	Understand
19.	What is coded BPSK modulation?	2	CO3	BTL2	Understand
20.	Define a coded DPSK demodulator.	2	CO3	BTL1	Remember
21.	State two merits of different types of spread spectrum systems.	2	CO3	BTL2	Understand
22.	Define a linear block code in receiver data detection.	2	CO3	BTL1	Remember
23.	Define a matched filter and give its correlation expression.	2	CO3	BTL2	Understand
24.	Define a binary (7,4) block code.	2	CO3	BTL1	Remember

PART B

Q.No	Questions	Marks	CO	BT Level	Competence
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1.	State and explain Shannon's channel coding theorem and derive the expression for the channel capacity of an AWGN channel.	(16)	CO3	BTL4	Analyze
2.	Explain the architecture of a block-coded digital communication system and describe how its performance is evaluated.	(16)	CO3	BTL3	Apply
3.	a) Explain orthogonal and bi-orthogonal signal sets.	(8)	CO3	BTL4	Analyze
	b) Compare their error performance with transorthogonal codes.	(8)	CO3	BTL4	Analyze
4.	Design a (7,4) Hamming code and explain its encoding procedure and single-error-correction decoding procedure.	(16)	CO3	BTL3	Apply
5.	Explain the construction and properties of Golay codes and discuss their error-correcting capability.	(16)	CO3	BTL3	Apply
6.	Analyze the encoding and decoding procedure of cyclic codes using generator polynomials with a suitable example.	(16)	CO3	BTL4	Analyze
7.	Explain the structure and syndrome decoding procedure of BCH codes.	(16)	CO3	BTL3	Apply
8.	Explain Reed-Solomon coding and analyze its effectiveness against burst errors.	(16)	CO3	BTL4	Analyze
9.	a) Explain the concept of matched-filter detection.	(8)	CO3	BTL4	Analyze
	b) Derive the condition for maximizing output SNR using a matched filter.	(8)	CO3	BTL4	Analyze
10.	Explain the principle of direct sequence spread spectrum communication and analyze its processing gain.	(16)	CO3	BTL4	Analyze
11.	Explain the working of coded BPSK and coded DPSK demodulators with the aid of block diagrams.	(16)	CO3	BTL3	Apply
12.	Design a space-time block code (Alamouti scheme) for a 2×1 MIMO system and explain its decoding procedure.	(16)	CO3	BTL3	Apply
13.	Analyze the coding gain achieved by linear block codes over uncoded transmission for a given channel condition.	(16)	CO3	BTL4	Analyze
14.	a) Compare block codes and convolutional codes in terms of structure and performance.	(8)	CO3	BTL4	Analyze
	b) Justify the choice of block codes for a burst-error channel.	(8)	CO3	BTL4	Analyze
15.	Analyze the performance of frequency-hopping spread spectrum systems and compare them with direct sequence spread spectrum.	(16)	CO3	BTL4	Analyze

UNIT IV - CONVOLUTIONAL CODED DIGITAL COMMUNICATION

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram –Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

PART A					
Q.No	Questions	Marks	CO	BT Level	Competence
1.	Define a convolutional code.	2	CO4	BTL1	Remember
2.	What are the parameters (n, k, K) of a convolutional encoder?	2	CO4	BTL1	Remember
3.	State the significance of the constraint length of a convolutional code.	2	CO4	BTL2	Understand
4.	Define the polynomial representation of a convolutional encoder.	2	CO4	BTL1	Remember
5.	What is a state diagram in convolutional coding?	2	CO4	BTL1	Remember
6.	Define the tree diagram representation of a convolutional code.	2	CO4	BTL2	Understand
7.	What is a trellis diagram?	2	CO4	BTL1	Remember
8.	Define maximum likelihood decoding.	2	CO4	BTL1	Remember
9.	What is the basic principle of the Viterbi algorithm for decoding?	2	CO4	BTL2	Understand
10.	Define the term "survivor path" in Viterbi decoding.	2	CO4	BTL1	Remember
11.	What is sequential decoding?	2	CO4	BTL1	Remember
12.	State one advantage of sequential decoding over Viterbi decoding.	2	CO4	BTL2	Understand
13.	Define threshold decoding.	2	CO4	BTL1	Remember
14.	What is meant by code rate in convolutional coding?	2	CO4	BTL2	Understand
15.	Define the free distance of a convolutional code.	2	CO4	BTL1	Remember
16.	What is hard-decision decoding?	2	CO4	BTL1	Remember
17.	What is soft-decision decoding?	2	CO4	BTL2	Understand
18.	Define turbo coding.	2	CO4	BTL1	Remember
19.	What is the role of an interleaver in turbo codes?	2	CO4	BTL2	Understand
20.	State the significance of iterative decoding in turbo codes.	2	CO4	BTL2	Understand
21.	Define the free distance of a convolutional code with example.	2	CO4	BTL1	Remember
22.	What is soft and hard-decision decoding?	2	CO4	BTL1	Remember
23.	Give the state diagram of convolutional coding for specific code ?	2	CO4	BTL1	Remember
24.	Define the tree diagram and trellis diagram representation of a convolutional code.	2	CO4	BTL2	Understand
PART B					

Q.No	Questions	Marks	CO	BT Level	Competence
1.	Explain the encoding process of a convolutional encoder using polynomial, state-diagram, and trellis-diagram representations for a given (n, k, K) .	(16)	CO4	BTL3	Apply
2.	Explain maximum likelihood decoding of convolutional codes and derive the decision rule.	(16)	CO4	BTL3	Apply
3.	a) Explain the Viterbi algorithm for decoding convolutional codes with a trellis example.	(16)	CO4	BTL4	Analyze
	b) Analyze its computational complexity.	(8)	CO4	BTL4	Analyze
4.	Explain sequential decoding (Fano/stack algorithm) and compare it with Viterbi decoding in terms of complexity and performance.	(16)	CO4	BTL4	Analyze
5.	Explain threshold decoding of convolutional codes and discuss its limitations.	(16)	CO4	BTL3	Apply
6.	Derive the error-probability performance expression for BPSK modulation with Viterbi decoding over an AWGN channel.	(16)	CO4	BTL4	Analyze
7.	Analyze the effect of constraint length and code rate on the error performance of convolutionally coded systems.	(16)	CO4	BTL4	Analyze
8.	a) Compare hard-decision and soft-decision Viterbi decoding.	(8)	CO4	BTL4	Analyze
	b) Analyze the coding-gain difference between them.	(8)	CO4	BTL4	Analyze
9.	Explain the structure and encoding process of turbo codes using parallel concatenated convolutional encoders.	(16)	CO4	BTL3	Apply
10.	Explain the iterative (turbo) decoding algorithm and analyze the role of the interleaver in improving performance.	(16)	CO4	BTL4	Analyze
11.	Design a rate-1/2, constraint-length-3 convolutional encoder and draw its trellis diagram for a 5-bit input sequence.	(16)	CO4	BTL3	Apply
12.	Analyze the performance of turbo codes compared to conventional convolutional codes near the Shannon limit.	(16)	CO4	BTL4	Analyze
13.	a) Explain the concept of puncturing in convolutional codes.	(8)	CO4	BTL4	Analyze
	b) Analyze how punctured codes achieve higher code rates.	(8)	CO4	BTL4	Analyze
14.	For a satellite communication link operating over a Rician fading channel, propose a suitable convolutional/turbo coding scheme and justify your choice.	(16)	CO4	BTL3	Apply
15.	Analyze the trade-offs between decoding complexity, latency, and error performance among Viterbi, sequential, and turbo decoding methods.	(16)	CO4	BTL4	Analyze

UNIT V - MULTICARRIER SYSTEMS

OFDM- Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Windowing; Peak to Average Power reduction schemes; Overview of GFDM, FBMC, UFMC, Multicarrier CDMA.

PART A					
Q.No	Questions	Marks	CO	BT Level	Competence
1.	Define OFDM.	2	CO5	BTL1	Remember
2.	What is the role of the IFFT in OFDM sub-carrier generation?	2	CO5	BTL1	Remember
3.	Define guard time in OFDM.	2	CO5	BTL2	Understand
4.	What is cyclic extension (cyclic prefix) in OFDM?	2	CO5	BTL1	Remember
5.	Why is windowing used in OFDM systems?	2	CO5	BTL2	Understand
6.	Define peak-to-average power ratio (PAPR).	2	CO5	BTL1	Remember
7.	List two PAPR reduction techniques.	2	CO5	BTL1	Remember
8.	What is clipping in the context of PAPR reduction?	2	CO5	BTL2	Understand
9.	Define the selective mapping (SLM) technique.	2	CO5	BTL1	Remember
10.	What is GFDM (Generalized Frequency Division Multiplexing)?	2	CO5	BTL1	Remember
11.	State one advantage of GFDM over OFDM.	2	CO5	BTL2	Understand
12.	Define FBMC (Filter Bank Multicarrier).	2	CO5	BTL1	Remember
13.	What is the main advantage of FBMC over OFDM?	2	CO5	BTL2	Understand
14.	Define UFMC (Universal Filtered Multicarrier).	2	CO5	BTL1	Remember
15.	What is multicarrier CDMA (MC-CDMA)?	2	CO5	BTL1	Remember
16.	State one advantage of MC-CDMA over single-carrier CDMA.	2	CO5	BTL2	Understand
17.	What is inter-carrier interference (ICI) in OFDM?	2	CO5	BTL1	Remember
18.	Define spectral efficiency in the context of multicarrier systems.	2	CO5	BTL2	Understand
19.	What is the significance of sub-carrier orthogonality in OFDM?	2	CO5	BTL2	Understand
20.	Mention one application of OFDM in modern wireless standards.	2	CO5	BTL1	Remember
21.	What is inter-symbol interference (ISI) in OFDM?	2	CO5	BTL1	Remember
22.	What is GFDM? Give its importance.	2	CO5	BTL1	Remember
23.	State one advantage of GFDM over MC-CDMA.	2	CO5	BTL2	Understand
24.	Mention one application of GFDM in modern wireless communication.	2	CO5	BTL1	Remember
PART B					
Q.No	Questions	Marks	CO	BT Level	Competence

1.	Explain the generation of OFDM sub-carriers using the IFFT/FFT operation with the block diagram of an OFDM transceiver.	(16)	CO5	BTL3	Apply
2.	a) Explain the concept of guard time and cyclic extension in OFDM.	(16)	CO5	BTL4	Analyze
	b) Analyze how the cyclic prefix mitigates ISI and ICI.				
3.	Explain the need for windowing in OFDM systems and analyze its effect on out-of-band spectral leakage.	(16)	CO5	BTL4	Analyze
4.	Analyze the problem of high PAPR in OFDM systems and explain the clipping-and-filtering technique for its reduction.	(16)	CO5	BTL4	Analyze
5.	Explain the selective mapping (SLM) and partial transmit sequence (PTS) techniques for PAPR reduction and compare their complexity.	(16)	CO5	BTL3	Apply
6.	Explain the architecture and working principle of GFDM and analyze its advantages over conventional OFDM.	(16)	CO5	BTL4	Analyze
7.	Explain the filter bank multicarrier (FBMC) technique and analyze how it improves spectral containment compared to OFDM.	(16)	CO5	BTL4	Analyze
8.	a) Explain the working principle of UPMC.	(8)	CO5	BTL4	Analyze
	b) Compare UPMC with OFDM and FBMC in terms of complexity and performance.	(8)	CO5	BTL4	Analyze
9.	Explain the transmitter and receiver structure of a multicarrier CDMA (MC-CDMA) system.	(16)	CO5	BTL3	Apply
10.	Analyze the performance of MC-CDMA in a multipath fading channel and compare it with conventional DS-CDMA.	(16)	CO5	BTL4	Analyze
11.	For a 5G-like wideband wireless system, propose a suitable multicarrier waveform (OFDM/GFDM/FBMC/UPMC) and justify your choice based on latency and spectral-efficiency requirements.	(16)	CO5	BTL3	Apply
12.	Analyze the effect of carrier frequency offset on inter-carrier interference in OFDM systems and suggest compensation techniques.	(16)	CO5	BTL4	Analyze
13.	a) Explain the concept of sub-carrier orthogonality in OFDM.	(8)	CO5	BTL4	Analyze
	b) Analyze the impact of timing and frequency synchronization errors on orthogonality.	(8)	CO5	BTL4	Analyze
14.	Design an OFDM system for a given bandwidth and delay spread, choosing an appropriate FFT size, guard interval, and sub-carrier spacing, and justify your design.	(16)	CO5	BTL3	Apply
15.	Compare OFDM, GFDM, FBMC, and UPMC waveforms in terms of PAPR, spectral efficiency, complexity, and suitability for 5G/6G applications.	(16)	CO5	BTL4	Analyze