TABLE OF CONTENTS

CHAPTER 1
Introduction to Intelligent Satellite Communication Systems **1-34**
1.1 Evolution of Satellite Communication
1.2 Fundamentals of Artificial Intelligence
1.3 Emergence of Generative and Agentic AI
1.4 Satellite Communication System Architecture
1.5 Space, Ground and User Segments
1.6 Role of AI in Satellite Communication
1.7 Intelligent Space-Based Communication Networks
1.8 Challenges and Opportunities in AI-Enabled Satellite Systems

CHAPTER 2
Satellite Communication Technologies and Engineering Fundamentals **35-72**
2.1 Orbital Mechanics and Satellite Classifications
2.2 Satellite Communication Subsystems
2.3 Satellite Payloads and Transponders
2.4 Ground Stations and Satellite Terminals
2.5 Satellite Link Budget and Power Analysis
2.6 Modulation, Coding and Multiple Access
2.7 Satellite Channel Characteristics and Propagation Effects
2.8 Non-Terrestrial Network Architectures

CHAPTER 3
Generative Artificial Intelligence: Foundations and Model Architectures **73-111**
3.1 Principles of Generative Artificial Intelligence
3.2 Machine Learning and Deep Learning Foundations
3.3 Neural Network Architectures
3.4 Generative Adversarial Networks and Variational Autoencoders
3.5 Transformer Models and Attention Mechanisms
3.6 Large Language Models and Foundation Models
3.7 Training, Fine-Tuning and Model Inference
3.8 Generative AI Evaluation and Limitations

CHAPTER 4
Generative AI Technologies for Satellite Communication Applications 112-149
4.1 Prompt Engineering and Instruction Design
4.2 Embeddings and Semantic Representation
4.3 Retrieval-Augmented Generation
4.4 Knowledge Bases for Satellite Communication
4.5 Multimodal Generative AI
4.6 Synthetic Data Generation for Satellite Networks
4.7 AI-Assisted Telemetry and Signal Analysis
4.8 Model Grounding, Validation and Hallucination Mitigation

CHAPTER 5
Agentic Artificial Intelligence: Principles and Intelligent Agent Architectures 150-184
5.1 Fundamentals of Agentic Artificial Intelligence
5.2 Generative AI and Agentic AI: Concepts and Distinctions
5.3 Intelligent Agent Architecture
5.4 Perception, Reasoning and Decision-Making
5.5 Goal-Oriented Planning and Task Decomposition
5.6 Agent Memory and Context Management
5.7 Tool Use, Function Calling and Action Execution
5.8 Autonomy, Human Oversight and Agent Evaluation

CHAPTER 6
Agentic AI Architectures and Multi-Agent Communication Systems 185-217
6.1 Agent Architecture Patterns and Workflow Design
6.2 Reactive, Deliberative and Hybrid Agents
6.3 Planning, Reasoning and Reflection Mechanisms
6.4 Tool-Calling Agents and Workflow Orchestration
6.5 Multi-Agent Communication and Collaboration
6.6 Role-Based Agents and Task Coordination
6.7 Knowledge-Grounded Agent Execution
6.8 Multi-Agent Architectures for Satellite Operations

CHAPTER 7
Generative AI Applications in Satellite Communication Engineering 218-251
7.1 Generative AI for Satellite System Modeling
7.2 AI-Assisted Satellite Link Budget Analysis
7.3 Generative Channel Modeling and Simulation
7.4 Synthetic Communication Data Generation

7.5 AI-Assisted Signal Processing and Modulation Analysis
7.6 Generative AI for Satellite Telemetry and Technical Documentation
7.7 Intelligent Ground Station Support
7.8 Generative AI for Satellite Network Design and Optimization

CHAPTER 8
Agentic AI for Autonomous Satellite Communication Operations **252-283**
8.1 Agentic AI for Satellite Mission Support
8.2 Autonomous Telemetry Monitoring and Interpretation
8.3 Intelligent Anomaly Detection and Fault Reporting
8.4 Agentic Satellite Network Monitoring
8.5 Intelligent Resource and Bandwidth Management
8.6 AI-Assisted Satellite Handover and Connectivity Management
8.7 Multi-Agent Ground Station Coordination
8.8 Human-in-the-Loop Decision Support for Space Systems

CHAPTER 9
AI-Enabled Non-Terrestrial Networks and Next-Generation Satellite Communications **284-314**
9.1 Fundamentals of Non-Terrestrial Networks
9.2 Satellite Integration with 5G and 6G Communications
9.3 LEO Satellite Constellations and Broadband Connectivity
9.4 AI-Based Satellite Network Planning
9.5 Intelligent Beam Management and Beam Hopping
9.6 AI-Assisted Routing and Mobility Management
9.7 Generative AI for Network Service Orchestration
9.8 Agentic AI for Autonomous NTN Coordination

CHAPTER 10
AI Engineering, Cybersecurity and Responsible Autonomous Satellite Systems **315-345**
10.1 AI Model Deployment for Satellite Communication
10.2 Edge AI and Onboard AI Processing
10.3 Resource-Constrained AI Inference
10.4 Model Compression, Quantization and Optimization
10.5 Cybersecurity in AI-Enabled Satellite Networks
10.6 Adversarial Attacks and AI Security
10.7 Reliability, Explainability and Agent Verification
10.8 Responsible AI and Safety-Critical Autonomous Operations