

WAVE PROPAGATION AND UNDERWATER ACOUSTICS

TABLE OF CONTENTS

I.	SURVEY OF WAVE PROPAGATION AND UNDERWATER ACOUSTICS (Joseph B. Keller)	
1.	Introduction.....	1
2.	Wave propagation in a deterministic medium.....	2
3.	Wave propagation in a stochastic medium.....	8
	References.....	12
II.	EXACT AND ASYMPTOTIC REPRESENTATIONS OF THE SOUND FIELD IN A STRATIFIED OCEAN (Daljit S. Ahluwalia and Joseph B. Keller)	
0.	Introduction.....	14
1.	Formulation and fundamental equations.....	16
2.	Time harmonic waves.....	19
3.	The homogeneous ocean of constant depth	
3.1	Introduction.....	21
3.2	Normal mode representation.....	23
3.3	Hankel transform representation.....	25
3.3A	Appendix.....	26
3.4	Ray representation.....	27
3.5	Connections between the representations.....	30
3.5A	Appendix.....	34
4.	The inhomogeneous stratified ocean of constant depth	
4.1	Introduction.....	36
4.2	Normal mode representation.....	38
4.3	Hankel transform representation.....	39
4.4	Multiple scattering representation.....	40
4.5	Connections between the representations.....	43
4.5A	Appendix.....	45

5. Asymptotic representations for the inhomogeneous stratified ocean of constant depth	
5.1 Introduction.....	46
5.2 Asymptotic form of the modal representation.....	46
5.2A Appendix.....	54
5.2B Appendix.....	61
5.2C Appendix.....	63
5.3 Asymptotic form of the Hankel transform representation.....	64
5.4 Asymptotic form of the multiple scattering representation.....	67
5.4.1 Explicit asymptotic form of the multiple scattering representation.....	68
5.5 Connections between the asymptotic forms of the representations.....	71
6. The ray representation	
6.1 Introduction.....	76
6.2 Geometrical construction of the ray representation.....	77
6.3 Analytic derivation of the ray representation.....	78
6.4 The ray representation for the stratified ocean of constant depth.....	82
References.....	85
III. HORIZONTAL RAYS AND VERTICAL MODES (Robert Burridge and Henry Weinberg)	
1. Introduction.....	86
2. Acoustic propagation in an almost stratified medium.....	88
3. Uniform asymptotic expansions in regions containing caustics.....	97
3.1 The field near a smooth caustic.....	97
3.2 A point source in an almost stratified medium.....	105
4. Space-time rays for more general time dependence.....	109
4.1 The ray theory.....	109
4.2 The excitation due to a point source.....	114
4.3 The Airy phase.....	118
4.4 The precursor and other phenomena requiring special treatment.....	123

VII

5.	Two theoretical examples.....	125
5.1	Homogeneous medium, one free horizontal boundary, one rigid boundary with small constant slope.....	125
5.2	Propagation in deep water for which the sound speed increases with depth.....	130
6.	Long range acoustic propagation in a deep ocean.....	134
6.1	Environmental parameters.....	134
6.2	The computer program.....	139
6.3	Comparison of computed amplitudes with observational data.....	143
	References.....	150
IV. WAVE PROPAGATION IN A RANDOMLY INHOMOGENEOUS OCEAN (Werner Kohler and George C. Papanicolaou)		
0.	Introduction.....	153
1.	The physical problem.....	155
2.	Asymptotic analysis of stochastic equations.....	163
3.	Application of asymptotic methods to coupled mode equations.....	170
4.	Coupled power equations.....	177
5.	Quasi-static and slowly-varying coupled power equations.....	180
	Appendix. First and second order perturbation theory for Boltzmann-like equations.....	187
6.	Coupled fluctuation equations.....	192
7.	Depth-dependent quantities.....	196
8.	High frequency approximation to coupled power equations.....	197
	Appendix A. Numerical study.....	213
	Appendix B. Diffusion approximation for coupled power equations with radiation loss.....	217
	References.....	222
V. THE PARABOLIC APPROXIMATION METHOD (Fred D. Tappert)		
1.	Basic concepts.....	224
2.	Derivations of parabolic equations.....	238
3.	Asymptotic analysis.....	266
4.	Summary.....	280

VIII

5. Acknowledgment.....	281
Appendix A. Historical survey of parabolic wave equation applications.....	282
References.....	285