CONTENTS

		Prefac	e	page xi
1	Inti	oducti Intro	on duction	1
	•	222020		-
2	Lin	ear wa	ve interactions	10
	2	Flow	s with piecewise-constant density and velocity	10
		2.1	Stability of an interface	10
		2.2	A three-layer model	14
		2.3	An energy criterion	17
		2.4	Viscous dissipation	19
	3	Flow	s with constant density and continuous velocity	
	profile		21	
		3.1	Stability of constant-density flows	21
		3.2	Critical layers and wall layers	23
	4 Flows with density stratification and piecewise-constant velocity			
			27	
		4.1	Continuously-stratified flows	27
		4.2	Vortex sheet with stratification	29
		4.3	Over-reflection and energy flux	31
		4.4	The influence of boundaries	33
	5	Flow	s with continuous profiles of density and velocity	35
		5.1	Unbounded shear layers	35
		5.2	Bounded shear layers	37
		5.3	The critical layer in inviscid stratified flow	41
		5.4	Diffusive effects	44

viii	Contents	

	6	Mode	els of mode coupling	45
		6.1	Model dispersion relations	45
		6.2	Mode conversion in inhomogeneous media	49
	7	Eiger	ivalue spectra and localized disturbances	51
		7.1	The temporal eigenvalue spectrum	51
		7.2	The spatial eigenvalue spectrum	58
		7.3	Evolution of localized disturbances	59
3	Intr	oducti	on to nonlinear theory	65
	8		duction to nonlinear theory	65
		8.1	Introductory remarks	65
		8.2	Description of a general disturbance	66
		8.3	Review of special cases	69
4	Wa	ves an	d mean flows	75
	9	Spati	ally-periodic waves in channel flows	75
		9.1	The mean-flow equations	75
		9.2	-	77
		9.3	The viscous wall layer	78
	10	Spati	ally-periodic waves on deformable boundaries	81
		10.1	The Eulerian drift velocity of water waves	81
		10.2	'Swimming' of a wavy sheet	84
	11	Mod	ulated wave-packets	87
		11.1	Waves in viscous channel flows	87
		11.2	Waves on a free surface	90
		11.3	Wave propagation in inhomogeneous media	95
		11.4	Wave action and energy	98
		11.5	Waves in inviscid stratified flow	100
		11.6	Mean flow oscillations due to dissipation	104
	12	Gene	ralized Lagrangian mean (GLM) formulation	105
		12.1	The GLM equations	105
		12.2	Pseudomomentum and pseudoenergy	108
		12.3	Surface gravity waves	109
		12.4	Inviscid shear-flow instability	111
	13	Spati	ially-periodic mean flows	113
		13.1	Forced motions	113
		13.2	Wave-driven longitudinal-vortex instability	120

Contents	i	X
Contents	i	X

5	Thi	ree-wav	ve resonance	123
	14	Cons	ervative wave interactions	123
		14.1	Conditions for resonance	123
		14.2	Resonance of capillary-gravity waves	125
		14.3	Some properties of the interaction equations	129
		14.4	Wave-interaction experiments	132
	15	Solut	tions of the conservative interaction equations	136
		15.1	The one-dimensional solutions	136
		15.2	Inverse-scattering solution in two dimensions	139
		15.3	Solutions in three and four dimensions	147
		15.4	Long wave-short wave interactions	150
	16	Linea	arly damped waves	151
		16.1	One wave heavily damped	151
		16.2	Waves dependent on t only	152
		16.3	Higher-order effects	159
	17	Non-	conservative wave interactions	161
		17.1	Resonant triads in shear flows	161
		17.2	The interaction equations	166
		17.3	Some particular solutions	170
6	Evo	olution	of a nonlinear wave-train	172
	18	Heur	istic derivation of the evolution equations	172
	19	1		176
		19.1	Surface and interfacial waves	176
		19.2	Internal waves	182
		19.3	Baroclinic waves	184
	20	Weakly nonlinear waves in shear flows		188
		20.1	Waves in inviscid shear flows	188
		20.2	Near-critical plane Poiseuille flow	190
		20.3	Non-critical (nearly) parallel flows	193
	21	Prop	erties of the evolution equations	199
		21.1	Nonlinear Schrödinger equation with real	
			coefficients	199
		21.2	Davey-Stewartson equations with real coefficients	204
		21.3	Nonlinear Schrödinger equation with complex	
			coefficients	206
		21.4	Korteweg-de Vries equation and its relatives	209
	22	Wave	es of larger amplitude	212
		22.1	Large-amplitude surface waves	212
		22.2	Higher-order instability of wave-trains	215

v	Contents
X	Comemis

		22.3	Numerical work on shear-flow instability	219	
		22.4	The nonlinear critical layer	226	
		22.5	Taylor-Couette flow and Rayleigh-Bénard		
			convection	229	
7	Cul	oic thre	ee- and four-wave interactions	231	
•	23		ervative four-wave interactions	231	
	25	23.1	The resonance condition	231	
		23.2		233	
		23.3	1	235	
		23.4	F	237	
			Properties of Zakharov's equation	241	
	24		e interactions in Taylor–Couette flow	244	
	27		Axisymmetric flow	244	
			Periodic wavy vortices	246	
			Effects of finite length	249	
			Doubly-periodic and 'chaotic' flow	253	
	25		eigh-Bénard convection	258	
	23	-	Introduction	258	
			Instabilities of rolls	259	
			Rolls in finite containers	264	
			Three-roll interactions	268	
	26		e interactions in planar shear flows		
	20		Three dominant waves	272	
		26.2		272	
		26.3	Direct computational approach	275 279	
		20.5	Direct computational approach	219	
8	Strong interactions, local instabilities and turbulence: a				
	postscript				
	27	Strong interactions, local instabilities and turbulence: a			
		posts	cript	282	
		27.1	Short waves and long waves	282	
		27.2	Local transition in shear flows	283	
		27.3	Some thoughts on transition and turbulence	286	
Re	eferei	nces		289	
In	_ *.			319	