

CONTENTS

Preface.....	(vii)
Acknowledgements.....	(ix)

PART ONE

FUNDAMENTALS AND METHODOLOGY

1. Introduction	3
2. Fracture	5
2.1 Ductile and Brittle Fractures	5
2.2 Fractography of Ductile and Brittle Fractures	6
2.3 Fatigue Fracture	10
2.4 Fractography of Fatigue Fracture	11
3. Tools and Techniques	13
3.1 Acquisition of Background Data	13
3.2 Selection of Samples	13
3.3 Photographic Records	14
3.4 Preliminary Examination	14
3.5 Nondestructive Testing	15
3.6 Chemical Analysis	15
3.7 Fractography, Energy Dispersive Analysis by X-Ray (EDAX), and Microscopy using Scanning Electron Microscope (SEM)	16
3.8 Optical Microscopy	18
3.9 Electron Probe Micro Analysis (EPMA)	18
3.10 X-Ray Diffraction	19
3.11 Evaluation of Mechanical Properties	19

PART TWO

CASE STUDIES

4. Material Selections	25
4.1 Case Study: Failure of Hip-Joint Prosthesis	26
4.2 Case Study: Failure of Firing Pin of 120mm Low Range Mortar	31

4.3	Case Study: Failure of Shaft of a Gearbox	34
4.4	Case Study: Failure of 7.62mm Cartridge Cases	37
4.5	Case Study: Failure of Fin Mounting Nuts	41
5.	Manufacturing Defects	45
5.1	Case Study: Failure of Track Pins of Track Link	48
5.2	Case Study: Failure of Track Shoe of an Infantry Combat Vehicle	51
5.3	Case Study: Failure of Control Lever of Fuel-Metering Unit of an Aeroengine	57
5.4	Case Study: Failure of Drill Rods for Mining	63
5.5	Case Study: Failure of Lifting Lugs of a Missile	68
5.6	Case Study: Failure of Breech Block of Light Machine Gun	71
5.7	Case Study: Failure of Titanium Sponge Cutting Ring	76
5.8	Case Study: Failure of Combustion Chamber Outer Casing of an Aeroengine	80
6.	Casting Defects in Iron and Steel	86
6.1	Case Study: Failure of Exhaust Outer Cone of an Aeroengine	88
6.2	Case Study: Failure of Sealing Rings of Centrifugal Breather of an Aeroengine	95
6.3	Case Study: Failure of Grinding Roll of a Bowl Mill	99
7.	Overload	103
7.1	Case Study: Failure of Mounting Bolt of Emergency Changeover Valve	104
7.2	Case Study: Failure of Steam Pipe in Unit-VI of a Thermal Power Station	108
7.3	Case Study: Failure of Body of Saddle Assembly	114
7.4	Case Study: Failure of Boiler Tube of a Thermal Power Station	118
8.	Fatigue	123
8.1	Case Study: Failure of Wheel Hub of an Aircraft	124
8.2	Case Study: Failure of Bolts of Flapjack Mounting Bracket of an Aircraft	129
8.3	Case Study: Failure of Compressor Rotor Blades of an Aeroengine	132
8.4	Case Study: Failure of Bearing Cage of an Aeroengine	137
9.	Corrosion	144
9.1	Case Study: Failure of Nipple of Fuel Pipe Line	146

9.2	Case Study: Failure of Condenser Tubes of Thermal Power Station	151
9.3	Case Study: Failure of High Pressure Air and Hydraulic Pipes	154
9.4	Case Study: Failure of Detonator of Grenade	157
10.	Hydrogen Embrittlement and Stress Corrosion Cracking	168
10.1	Case Study: Failure of Fin Mounting Screws of an Aero Weapon	169
10.2	Case Study: Failure of Differential Valve Cover of Fuel Metering Unit	172
10.3	Case Study: Failure of Lever Assembly of Main Under Carriage of an Aircraft	176
10.4	Case Study: Failure of Cartridge Seat Ejection Secondary of an Aircraft	181
11.	Wear	190
11.1	Case Study: Failure of Interrotor Bearing of an Aeroengine	192
11.2	Case Study: Failure of Low Temperature Super Heater Tube of a Thermal Power Station	201
11.3	Case Study: Failure of Main Landing Gear Assembly of an Aircraft	205
11.4	Case Study: Failure of Coupling Shaft and Bevel Gear of an Aeroengine	215
12.	Elevated Temperature Failures	221
12.1	Case Study: Failure of a Bolt of Nozzle Guide Vane of an Aeroengine	222
12.2	Case Study: Failure of Vanes of Front Nozzle Diaphragm Assembly of an Aeroengine	226
12.3	Case Study: Failure of Center Main Bearing of an Aircraft Engine	235
12.4	Case Study: Failure of Jet Nozzle Casing of an Aeroengine	240
12.5	Case Study: Failure of Turbine Stator Vanes of an Aeroengine	244
	Bibliography	253
	Index	257