

Contents

<i>Foreword</i>	(vii)
<i>Preface</i>	(ix)
<i>Acknowledgement</i>	(xiii)

CHAPTER 1

The Sun	1
<i>Questions</i>	9
<i>Answers</i>	10

CHAPTER 2

The Motion of the Earth	11
2.1 The Changing Lengths of Day and Night Time	14
2.2 Precession and Tides.....	16
2.3 Meaning and Definitions of Some Terms.....	18
<i>Questions</i>	20
<i>Answers</i>	23

CHAPTER 3

The Atmosphere	24
3.1 Composition of the Atmosphere	24
3.2 Atmospheric Heat Process	25
3.3 The Vertical Structure of the Atmosphere Based on Temperature	25
3.4 International Standard Atmosphere (ISA)	30
3.5 Jet standard Atmosphere (JSA)	31
<i>Questions</i>	34
<i>Answers</i>	40

CHAPTER 4

Atmospheric Pressure.....	42
4.1 Pressure Variation with Altitude	45
4.1.1 Pressure Variations.....	46
4.2 Barometric Pressure Corrections for Standard Conditions	46
4.3 Types of Mercury Barometers	47
4.4 Pressure Patterns	48
4.5 Mean Sea Level (msl) Pressure Distribution	49
4.6 Pressure Gradient.....	50
4.7 Pressure Tendency	51
4.7 The Semidiurnal Variation of Pressure.....	51
<i>Questions</i>	52
<i>Answers</i>	55

CHAPTER 5

Altimetry	56
5.1 The Pressure Altimeter	57
5.1.1 The Simple Altimeter	58
5.2 Standard Altimeter Setting (SAS)	60
5.3 Some Terms and Q-code used in Aviation	60
5.4 Altimeter Setting.....	61
5.5 Transition Altitude (TA) Computation.....	63
5.6 Transition Level.....	63
5.7 Standard Procedure of Altimeter Setting	64
5.8 Altimeter Temperature Error Correction	65
<i>Questions</i>	75
<i>Answers</i>	80

CHAPTER 6**Density and Density Altitude 81**

6.1	Density Altitude.....	82
6.2	Aircraft Performance	90
	<i>Questions</i>	98
	<i>Answers</i>	102

CHAPTER 7**Water in the Atmosphere 104**

7.1	State Variables.....	109
7.2	Types of Atmospheric Physical Processes.....	110
7.3	Moisture Variables.....	112
	<i>Questions</i>	118
	<i>Answers</i>	126

CHAPTER 8**Temperatures, Lapse Rates and
Stability of Atmosphere..... 128**

8.1	Temperature.....	128
8.2	Diurnal Variation of Temperature	133
8.3	Adiabatic Lapse Rates	134
8.4	Stability and Instability of the Atmosphere	138
	8.4.1 Absolute Stability	139
	8.4.2 Absolute Instability	141
	8.4.3 Conditional Instability	143
8.5	Flying Conditions in Stable Air.....	145
8.6	The Dew Point Lapse Rate	145
8.7	Thermodynamic Diagrams	147
	8.7.1 T- ϕ gram.....	149
	<i>Questions</i>	150
	<i>Answers</i>	157

CHAPTER 9

Atmospheric Aerosols and Turbulence	158
9.1 Formation and Dispersal of Clouds	160
9.2 Atmospheric Turbulence	161
9.3 Temperature Inversions	162
<i>Questions</i>	165
<i>Answers</i>	170

CHAPTER 10

Cloud Classification	171
10.1 Clouds are Grouped into Ten Genera	172
10.2 Definition of a Cloud	174
10.3 Special Clouds	184
<i>Questions</i>	188
<i>Answers</i>	193

CHAPTER 11

Meteors, Cloud Formation and Dissipation	194
11.1 Meteors	194
11.2 Methods of Cloud Formation	203
11.3 Vertical Current Developed by Ground Contours	209
11.3.1 Standing Lee Waves	212
<i>Questions</i>	213
<i>Answers</i>	218

CHAPTER 12

Precipitation Processes	217
12.1 Growth of Droplets by Collision	221
12.2 Growth of Droplets by Coalescence	221
12.3 The Bergeron (Ice Crystal) Process	222

12.4	Effects of Precipitation in Aviation	223
12.5	Diurnal and Seasonal Variation of Rainfall	224
12.6	Precipitation Measurement	224
12.7	Record Rainfall in India.....	226
	<i>Questions</i>	226
	<i>Answers</i>	229

CHAPTER 13**Thunderstorms..... 230**

13.1	Time Scale Order.....	231
13.2	Thunderstorm.....	232
13.2.1	Types of Thunderstorms in Classical Approach	233
13.3	Conditions Favorable for the Development of Cb.....	233
13.4	The Life Cycle of a Thunderstorm Cell.....	234
13.5	Regeneration of Thunderstorms or Chain Action or Self Propagating Storms	235
13.6	Lightning	236
13.7	The Lightning Discharge	237
13.7.1	Charge Separation in Clouds	238
13.7.2	Lightning Discharge within Between Clouds and Earth	239
13.8	Different Types of Electrical Discharges in the Atmosphere.....	240
13.9	Static Electricity and its Effects in Aviation.....	241
13.9.1	Precipitation Static.....	241
13.9.2	Cloud Burst.....	241
13.10	Diurnal and Seasonal Variation of Thunderstorms over India.....	242
	<i>Questions</i>	243
	<i>Answers</i>	250

CHAPTER 14**Aviation Hazards Associated with Thunderstorms... 251**

- 14.1 Avoidance and Flying Techniques in Thunderstorms253
Questions258
Answers.....260

CHAPTER 15**Radar and its Application in Weather Detection..... 261**

- 15.1 Principle of Radar262
15.2 The Plan Position Indicator (PPI).....265
15.3 Types of Ground Radars used in Aviation.....269
15.4 Some Characteristics of Weather Radar Echoes.....270
15.5 Iso-Echo Contour Display273
15.6 The Main uses of Weather Radars.....274
Questions274
Answers.....277

CHAPTER 16**Hailstorms..... 278**

- 16.1 Hail Hazard in Aviation.....281
16.2 Hail Formation in the Cloud282
16.3 Favourable Synoptic Conditions.....282
16.4 Microburst284
16.5 Microburst Models.....287
Questions290
Answers.....293

CHAPTER 17**Tornadoes, Waterspouts, Dust Devils..... 294**

- 17.1 Tornadoes294
17.2 Waterspouts301
17.3 Dust-Devils302
Questions303
Answers.....305

CHAPTER 18

Ice Accretion on Aircraft	306
18.1 Types of Airframe Icing	307
18.2 Effect of Airframe Icing on Performance	310
18.3 Engine Icing.....	311
18.4 Icing on Parked Aircraft	315
18.5 Aircraft Icing in Flight.....	316
18.6 Icing in Clouds and in Precipitation	320
18.7 Preflight Action	322
<i>Questions</i>	323
<i>Answers</i>	329

CHAPTER 19

Visibility and Fog.....	330
19.1 Factors that affect the Visibility	332
19.2 Types of Fogs	335
19.3 Visibility Measurements in Airport	338
19.4 Fog Dispersal.....	338
19.5 Horizontal, Slant and Vertical Visibility	339
<i>Questions</i>	340
<i>Answers</i>	344

CHAPTER 20

The Surface Wind	345
20.1 Winds below 2000 ft (agl).....	357
20.2 Diurnal Variation of Wind within Friction Layer.....	358
20.3 Local Winds.....	358
20.4 Pressure and Wind	365
20.5 Geostrophic Wind.....	367

20.6	Gradient Wind	370
20.7	Cyclostrophic Wind	374
20.8	Thermal Wind	375
	<i>Questions</i>	378
	<i>Answers</i>	384

CHAPTER 21

Divergence, Vortical Motion and Vorticity 385

21.1	Fields of Divergence	386
21.2	Flight in the Fields of Low Level Convergence (Low) and Divergence (High)	389
21.3	Fields of Vorticity	389
21.4	Convergence and Divergence Due to Surface Friction in Northern Hemisphere	393
21.5	Vertical Motion	393
	<i>Questions</i>	397
	<i>Answers</i>	399

CHAPTER 22

Wind Shear, Clear Air-Turbulence and Jet Streams 400

22.1	Wind Shear	400
22.1.1	Wind Shear Warnings	402
22.1.2	Effects of Wind Shear on Take-off and Landing Performance	403
22.1.3	Wind Shear Alerts and Warnings	405
22.2	Clear Air Turbulence (CAT)	405
22.2.1	Avoidance of Turbulence	410
22.2.2	Empirical rules favorable to the occurrence of CAT: In the Vicinity of	411
22.2.3	Incidence of CAT over India	412

22.3	Jet Streams	412
22.3.1	Types of Jet Streams	414
22.3.2	Jet Streams over India.....	417
22.4	Westerly Waves	420
22.5	Easterly Waves	420
	<i>Questions</i>	422
	<i>Answers</i>	431

CHAPTER 23**Air Masses and Fronts..... 432**

23.1	Definition of Air Mass.....	432
23.2	Classification of Air Masses	433
23.3	Modifications of Air Masses	435
23.4	Air Masses over the Indian Region.....	437
23.4.1	Air Mass Identification	438
23.5	Air Mass Fronts	439
23.5.1	Warm and Cold Fronts	442
23.5.2	Summary of Frontal Characteristics	446
23.5.3	Representation of Fronts on msl Synoptic Chart	447
23.5.4	Frontal Depressions	448
23.5.5	Weather Associated with a Mature Extra-Tropical Wave Depression	449
23.5.6	Families of Frontal Depressions	450
23.5.7	Secondary Depressions or Lows.....	450
23.5.8	Flying Hazards Associated with Polar Front Depressions.....	451
23.5.9	Other Depressions.....	451
	<i>Questions</i>	453
	<i>Answers</i>	460

CHAPTER 24

Tropical Meteorology	462
24.1 Tropical Discontinuities.....	467
24.2 Waves and Depressions on ITCZ	470
<i>Questions</i>	472
<i>Answers</i>	476

CHAPTER 25

Tropical Cyclone	477
25.1 What are Tropical Cyclone	478
25.2 Life Cycle of a Tropical Cyclone	479
<i>Questions</i>	487
<i>Answers</i>	490

CHAPTER 26

Monsoons	491
26.1 Indian Summer Monsoon	493
26.2 Breaks in the Monsoon	500
26.3 Northeast Monsoon.....	503
<i>Questions</i>	505
<i>Answers</i>	507

CHAPTER 27

The General Circulation of the Atmosphere.....	508
27.1 Zonal Index.....	513
27.2 Global Temperature Distribution.....	514
<i>Questions</i>	519
<i>Answers</i>	525

CHAPTER 28

Climatology.....	526
<i>Questions</i>	530
<i>Answers</i>	533

CHAPTER 29**Climate of India 534***Questions* 542*Answers* 547**CHAPTER 30****Western Disturbances and Summer****Thunderstorm over India 548**

30.1 Western Disturbances (WD) 548

30.2 Summer Thunderstorms over India 551

30.2.1 Norwesters 553

30.2.2 Thunderstorms and Dust-storms
over North-west India 554

30.2.3 Thunderstorms Over South Peninsula 555

30.2.4 Hailstorms 555

Questions 555*Answers* 560**CHAPTER 31****General Aviation Services 561**

31.1 Air Traffic Services (ATS) 578

31.2 Communication Services 579

31.3 Meteorological Services 580

Questions 583*Answers* 584**CHAPTER 32****Meteorological Services for****International Air Navigation 585**

32.1 International Standards Recommended Practices 585

32.2 Objective, Determination and Provision
of Meteorological Services 592

32.3 Some Definitions used in Air Traffic Services 594

32.4	IMD set up of Meteorological Offices for Aviation	595
32.4.1	Responsibilities of Aerodrome Meteorological Offices (AMOs).....	597
32.4.2	Responsibilities of Aeronautical Meteorological Stations (AMSs)	598
32.4.3	Responsibilities of the Meteorological Watch Offices (MWOs).....	598
32.4.4	Responsibilities of Tropical Cyclone Advisory Centre (TCAC)	599
	<i>Questions</i>	600
	<i>Answers</i>	602

CHAPTER 33

World Area Forecast System (WAFS)..... 603

33.1	World Area Forecast System (WAFS)	603
33.2	World Area Forecast Center (W AFC).....	603
33.3	Responsibilities of W AFC	604
33.4	The Criteria for Issuing Amendments to WAFS Products.....	605
33.5	Regional Area Forecast Centers (RAFC)	605
33.5.1	Regional Area Forecast System (RAFS)	607
33.6	Utilization of WAFS Products.....	608
33.7	Significant Weather Chart	610
	<i>Questions</i>	612
	<i>Answers</i>	615

CHAPTER 34

Meteorological Observations 616

34.1	Synoptic Observations are made at Fixed Universal Time (UTC).....	618
34.2	Units of Measurements	619
34.3	Observatory Enclosure.....	620
34.4	Automatic Weather Observing Systems (AWOS).....	621
34.5	Upper Air Observations	622

34.6	Direct Reception System (DRS).....	623
34.7	Satellite Imagery Reception and Video Display System (SIRAVDS).....	623
34.8	Meteorological Message Handling System (MMHS).....	624
34.9	The Effects of Weather on Aircraft	624
	<i>Questions</i>	626
	<i>Answers</i>	629

CHAPTER 35

Satellite Meteorology	630	
35.1	Satellite Meteorology.....	630
35.2	Satellite Pay Loads, TV Camera.....	642
35.3	Remote Sensing	644
35.4	Geostationary Satellites	645
35.5	IMDPS (INSAT Meteorological Data Processing System)	646
	<i>Questions</i>	647
	<i>Answers</i>	648

CHAPTER 36

Climatology for Aviators.....	649	
36.1	Introduction	649
36.2	North Polar Regions	652
36.3	North Atlantic (lat 30° N to 60° N).....	652
36.4	North America	655
36.5	South Atlantic, South America.....	656
36.6	Africa.....	659
36.7	Mediterranean – Europe – Middle East	662
	36.7.1 Mediterranean.....	662
	36.7.2 Central Europe.....	663
	36.7.3 Middle East.....	664
36.8	Asia-Indian Ocean	665

36.9	Australia.....	669
36.10	Pacific	672
36.10 (a)	Singapore – Japan	673
36.10 (b)	Singapore – Australia.....	674
36.10 (c)	Southwest Pacific (New Zealand).....	674
36.10 (d)	North Pacific	675
	<i>Questions</i>	676
	<i>Answers</i>	682

CHAPTER 37**Aviation Weather Reports and Codes 683**

37.1	Aviation Weather Codes.....	684
37.2	METAR/SPECI Code.....	684
37.3	Notes on Reporting	693
37.4	Landing Forecast	699
37.5	Significant changes that form the Criteria for Inclusion in the Trend Forecast	701
37.6	Criteria for Issuing SPECI.....	707

CHAPTER 38**Aviation Weather Forecasts and Codes..... 710**

38.1	Aerodrome Forecast.....	710
38.1.1	Criteria for Inclusion of change group in Aerodromes Forecast	715
38.1.2	Period of Validity of Routine Aerodrome Forecasts	716
38.1.3	IMD Routine Aerodrome Forecasts.....	717
38.2	Dissemination of TAF	718
38.2.1	ROBEX Collection and Dissemination of TAF Bulletins	718
38.3	Landing Forecast	725
38.4	Take-off Forecast	725
38.5	Operationally Desirable Accuracy of Forecasts	727
38.6	Local and Area Forecast	728

38.7 Area Forecast Qode Form.....	729
38.8 ROFOR.....	739
38.9 WINTEM.....	746

CHAPTER 39

SIGMET and AIRMET Information and Aerodrome Warnings 751

39.1 SIGMET	751
39.2 AIRMET Information.....	755
39.3 Aerodrome Warnings.....	756
39.4 Low Level Wind Shear Warnings	758
39.4.1 Evidence of Existence of Wind shear shall be Derived From	759
39.4.2 Format Dissemination of Wind shear Warning	759
39.4.3 Information for Parked and Moored Aircraft	760
39.5 RAREP	760
39.6 CODAR (Upper air report from an aircraft).....	763

CHAPTER 40

Meteorology for Helicopter Operations..... 766

40.1 Weather forecast for Gliders and Ballooning	769
--	-----

Question Bank 773

Appendix..... 805

References 891

Index..... 893