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Time evolution of meteorological training and education in India

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सार – विश्व मौसम विज्ञान संगठन के दो क्षेत्रीय प्रशिक्षण केंद्र (WMO RTC) घटकों के माध्यम से सामान्य मौसम विज्ञान, कृषि मौसम विज्ञान और मौसम संबंधी उपकरणों और दूरसंचार के विषयों में भारत मौसम विभाग की प्रशिक्षण सेवाओं के समय क्रम का पता लगाने का प्रयास किया गया। मौसम विज्ञान और प्रचालनात्मक जल विज्ञान में कार्मिकों की शिक्षा और प्रशिक्षण के लिए दिशा-निर्देश (WMO- संख्या 258) के ढांचे में इन RTC द्वारा आयोजित प्रशिक्षण पाठ्यक्रमों की सफलता को राष्ट्रीय और अंतर्राष्ट्रीय हितधारकों के साथ-साथ WMO और अन्य संबंधित अंतर्राष्ट्रीय संगठनों द्वारा व्यापक रूप से मान्यता दी गई। प्रशिक्षण पाठ्यक्रम का डिज़ाइन WMO और ICAO द्वारा निर्धारित योग्यता आवश्यकताओं को पूरा करता है। मौसम विज्ञान और जल विज्ञान में प्रगति को प्रतिबिंबित करने वाले कुछ नए प्रशिक्षण पाठ्यक्रम भी प्रशिक्षुओं की क्षमताओं को बढ़ाने के लिए अद्यतित संख्यात्मक उत्पादों के उपयोग में लाए गए। प्रशिक्षण दक्षता बढ़ाने के लिए प्रत्यक्ष शिक्षण के अलावा कुछ अन्य प्रशिक्षण पाठ्यक्रमों के लिए मिश्रित शिक्षण शुरू किया गया।

ABSTRACT. An attempt has been made to trace out the time evolution of training services of India Meteorological Department in the disciplines of General Meteorology, Agricultural Meteorology, and Meteorological instruments & telecommunication through its two World Meteorological Organization Regional Training Centre (WMO RTC) components. The success of the training courses which are organized by these RTCs in the framework of Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology (WMO- No. 258) has been widely recognized by the national and international stakeholders as well as the WMO and other related international organizations. The design of the training syllabi fulfils the competency requirements, set by WMO & ICAO. Some new training courses which reflect the advances in meteorology and hydrology have also been offered to enhance the capabilities of trainees in the use of the up-to-date numerical products. In addition to face-to-face teaching, blended learning has been introduced for some training courses to enhance the training efficiency.

Key words – Training, WMO, RTC.

1. Introduction

The Science of Meteorology & Climatology is multi-disciplinary in nature. Previously, formal academic institutes did not have these subjects in their curriculum. In the recent past, there are many institutes which have curricula on Atmospheric Science/ Environmental Science/ Oceanography *etc*., focusing on the theoretical aspects. Imparting professional training on operational aspects of these subject remains the domain of IMD.

India Meteorological Department (IMD) recruits scientific personnel in Group-A and Group-B (Non-Gazetted) cadres, most of whom are not from the background of Atmospheric Science or Meteorology. Hence capacity building and training of the personnel recruited in IMD at different cadre levels is very much essential for them to perform the varied roles in weather forecasting and meteorological instrumentation.

IMD is a pioneer in Meteorological education in India. Formal training courses in General Meteorology were started at IMD, Pune in 1943 and that in Meteorological Instrumentation & Telecommunication started in mid-seventies at IMD, New Delhi. The Agricultural Meteorology Division of India Meteorological Department (IMD), established in Pune, in 1932, started imparting training as a pioneer organization in the field of agricultural meteorology since 1950. Separate training unit of the Agricultural Meteorology Division was started in the year 1976. Gradually, the demand from various organizations including the professors from agricultural university increased for conducting courses in agricultural meteorology. The Training unit of the Division is conducting various courses, routinely in the field of agricultural meteorology as per approved academic calendar. The courses are meant for both the departmental as well as non-departmental candidates from grass-root level (*i.e.* Observers) to senior levels (*i.e.* Professors / senior officers / scientists).

The WMO Executive Council at its 38th session approved the designation of the training facilities of India Meteorological Department in New Delhi and Pune as WMO Regional Training Centre (RTC) for the Regional Association II (Asia) in the year 1986. In accordance with the procedures laid down for the formal recognition of the RTC, an agreement was drawn up and signed on the behalf of India by Dr. R. P. Sarkar, the then Director General of IMD and on behalf of WMO by Professor G.O.P Obasi, the then Secretary General of WMO on 15th June 1988, a red-letter day in the annals of IMD's training service. Picture of the said historical moment is given in Fig. 1.

Since 1988, the training centers of IMD at Pune and New Delhi are functioning as two components of WMO RTC in India in General Meteorology, Climate/Climatology, Agricultural Meteorology, Aviation Meteorology, Seismology and Meteorological instruments & telecommunication. The primary objective of the training service of IMD is the building up and strengthening of the capacity of personnel of IMD, personnel from National Meteorological and Hydrological Services of the countries in Afro-Asia & Pacific regions and from other Government of India departments at different levels, in the field of operational Weather & Climate Services,

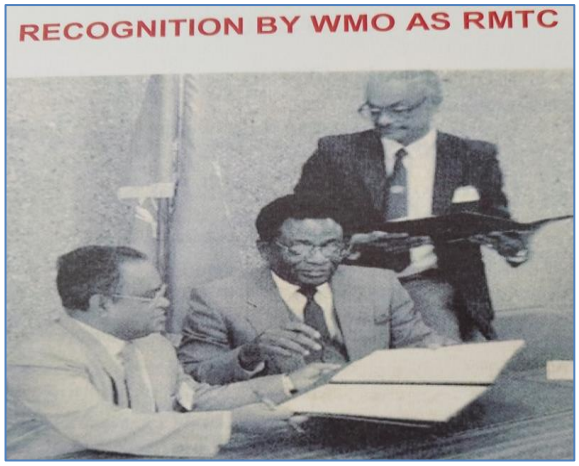

Fig. 1.

Hydrometeorology, Agriculture Meteorology, Meteorological Instruments, Communication & Information System, enabling them to meet their required job competencies.

The primary objectives are supplemented by several secondary objectives, like, development, augmentation and maintenance of infrastructure regularly, monitoring and evaluating the training processes to determine improvements, changes and corrective measures by a suitable Training Advisory Committee, updating the training curricula by revising it in a regular interval of time, developing short training contents/modules, upgrading the knowledge, Skill & Attitude of trainer/training resource personnel through different faculty development programs.

1.1. *Categorization of trainings imparted by IMD*

Various customized, tailor-made modules of refresher training courses and short term training programmes ranging from one to few weeks period are designed to fulfill the objective enumerated in paras above. Training programs conducted by IMD are broadly categorized into four categories. *viz*. Ab-initio training, career progression training, Orientation training and refresher training. First three are long-term with duration ranging from 2 to 12 months and the last one is short term with duration a few weeks.

2. Training data

Organizational structure of IMD's training program is given as a block diagram in Fig. 2a. Stake holders of different training programs of IMD is given as a block diagram in Fig. 2b. Details of the countries, personnel in which, have been trained in the above mentioned RTCs, is given in Fig. 3. Histogram for number of personnel, trained in different levels, at these two RTCs is given in Fig. 4.

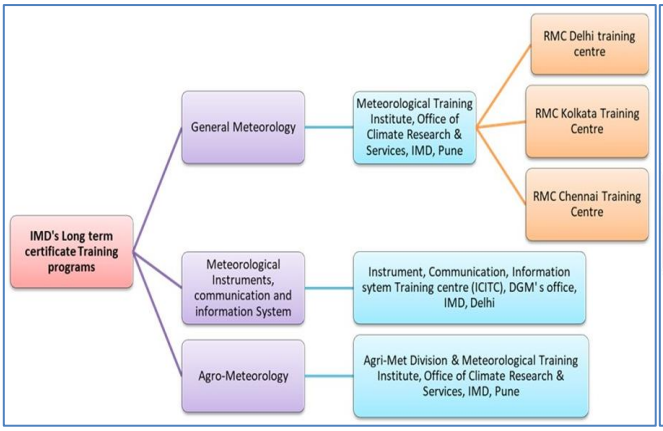

Fig. 2a. Organizational structure of training in IMD

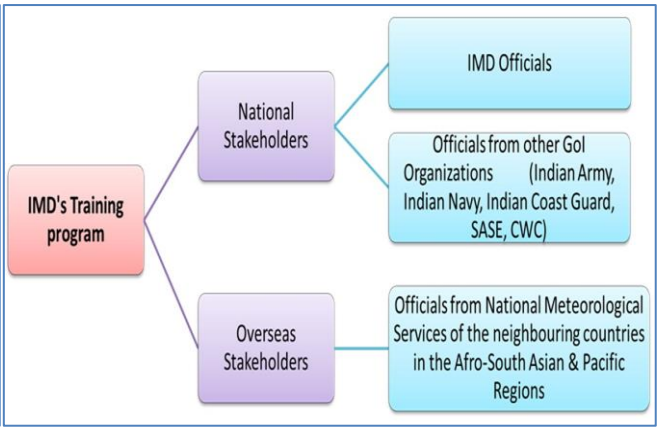

Fig. 2b. Stake holders/beneficiaries of IMD training.

FOREIGN TRAINEES TRAINED IN GENERAL METEOROLOGY TILL DECEMBER 2022 = 318

AFGHANISTAN	21	GHANA	01	LESOTHO	10	NEPAL	07	SRI LANKA	29	UAE	02
BANGLADESH	21	IRAN	02	MALDIVES	35	NEW GUINEA	02	SUDAN	05	UGANDA	01
BHUTAN	20	INDONESIA	02	MAURITIUS	23	NIGERIA	12	SYRIA	09	VANUATU	01
DOHA QATAR	02	KENYA	01	MALAYSIA	11	OMAN	03	TANZANIA	02	VIETNAM	06
EAST AFRICA	03	KOREA	03	MONGOLIA	02	PHILIPPINES	04	THAILAND	03	YEMEN	14
ETHIOPIA	35	LAOS	04	MYANMAR	02	SEYCHELLES	01	TRINIDAD & TOBAGO	01	ZAMBIA	01
CAMEROON	12									FIJI	05

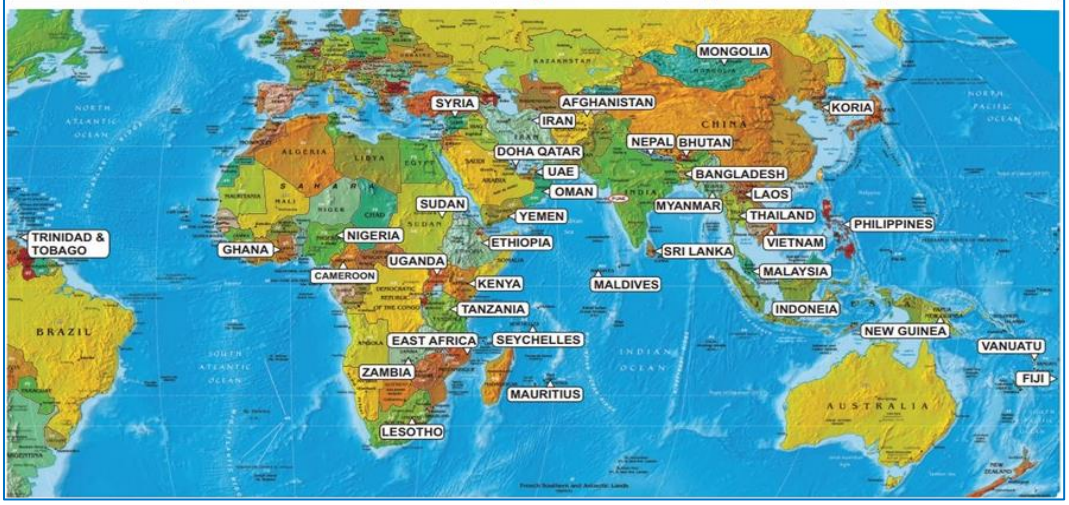

Fig. 3. **Details of foreign trainees trained in General Meteorology**

Details of refresher courses been conducted is given in Table 1. Structure of the 4 long term routine certificate courses in the discipline of General Meteorology, *viz*., Integrated Meteorological Training Course, Forecasters training course, Advanced Meteorological training course and Trainee Met-Gr II training course including the different subjects taught and marks allotted to individual subject in the final examination are given in Table 2. All training programs are executed following a fixed calendar, given in Table 3.

2. Training methodology

3.1. *Time evolution of the pattern of training courses*

3.1.1. *Early pattern since inception*

In the early years, a seamless training system was in vogue in IMD for different cadres of people. The total length of the training was 12 months, consisting of Elementary Phase, followed by Intermediate Phase and Advanced Phase. Officers of IMD in the cadre of Assistant Meteorologists and Professional Assistants, officers from Indian Navy, Indian Air Force and Indian Coast Guard underwent advanced training for the entire period of one year. Senior observers requiring knowledge only on observational aspects and Meteorological theory underwent the training for the initial Elementary Phase. Scientific Assistants promoted from Senior Observer rank

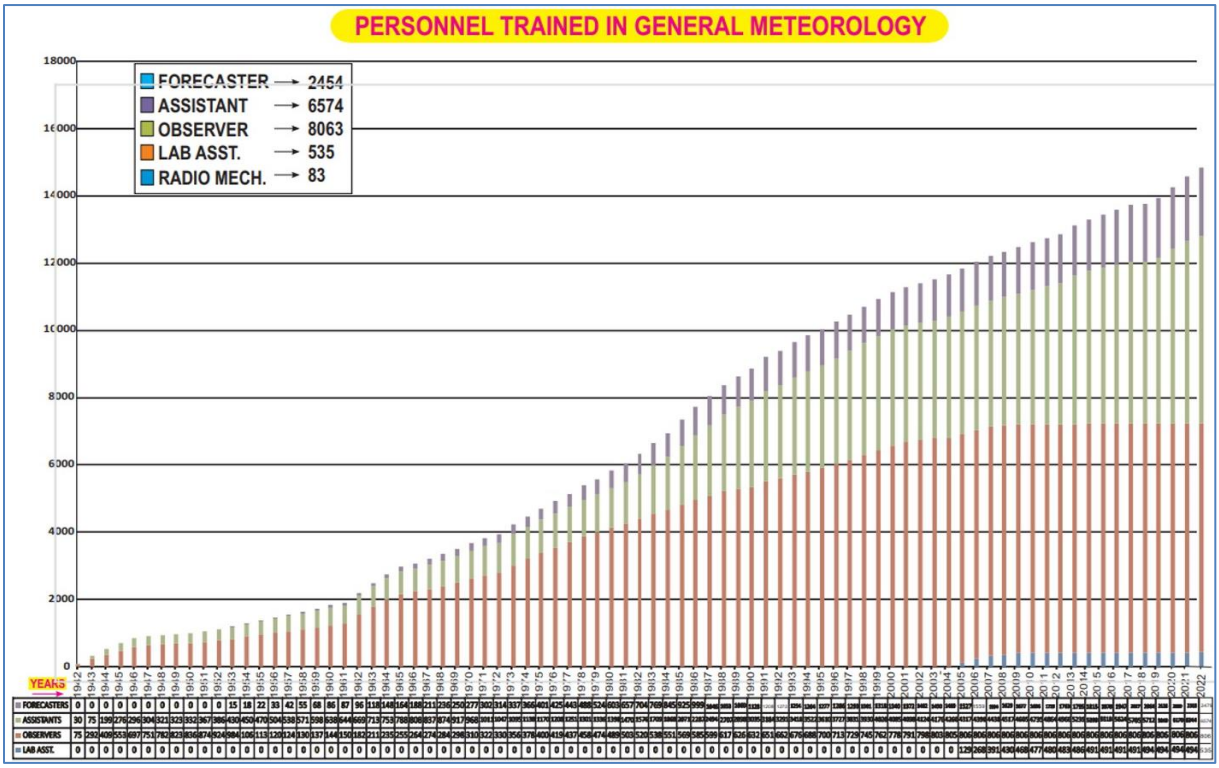

FIG. 4. Histogram for number of personnel, trained in different levels.

TABLE-1

Advanced refresher courses conducted so far

1.	June 1970	Stratospheric Meteorology	36	July 2007	Direct Trainer skills course conducted jointly by MoES & IMD at CTI, Pune
2.	March 1971	Numerical Weather Prediction	37	Sept. 2007	Met Training course for observers of Army/SASE, (Conducted at MMC Srinagar) under project PARWAT
3.	May 1972	Hydrometeorology	38	Sept. 2007	Direct Trainer skills course conducted jointly by MoES & IMD at Goa.
4.	March 1974	Agricultural Meteorology	39	Dec 2007	First Advanced course on Astronomy
5.	Feb. 1975	Satellite Meteorology	40	May 2008	Met. Training course for observers of Army/SASE, (Conducted at MMC Srinagar) under project PARWAT.
6.	Oct. 1975	Aeronautical Meteorology	41	May 2008	Refresher Course on Hydrometeorology for staff working at FMO.
7.	Feb. 1976	Tropical Cyclones	42	May 2008	Met. Training course for observers of Army/SASE, (Conducted at MMC Srinagar) under project PARWAT.
8.	Dec. 1976	Numerical Weather Prediction	43	July 2009	Mid level update Course for Naval met. officers
9.	Feb. 1977	*Agricultural Meteorology*	44	Nov. 2009	Aviation Meteorology.
10.	Dec. 1977	Atmospheric Waves	45	March 2010	Workshop for Journalists under Outreach Programme
11.	Feb. 1984	Synoptic Analysis in Tropics with special reference in Aeronautical Meteorology	46	March 2010	Workshop for Teachers under Outreach Programme
12.	April 1989	Short Range Weather Prediction including use of Numerical Weather Prediction products	47	Sept. 2010	WMO CLIPS Workshop on Urban Climatology

TABLE 1 (*Cont.)*

13.	Jan. 1991	Cyclone Warning	48	Sept. 2011	Aviation Refresher Course
14.	Sept. 1991	Aviation Meteorology	49	Nov. 2011	Mid-level update Course for Naval met. Officers
15.	Sept. 1992	Cyclone Warning (Emphasizing operational aspects and use of PCs in operational work)	50	Nov. 2012	Application of DWR Products in NWP
16.	Dec. 1993	Aviation Meteorology (SAARC Seminar cum Training Workshop)	51	Dec. 2013	Short term Training course in General Meteorology
17.	Sept. 1994	Satellite and Radar inputs for Cyclone Warning (Conducted at New Delhi)	52	Nov. 2014	WMO Group Training Course "Instrument Maintenance & Calibration"
18.	May 1995	Operational Numerical Weather Prediction models	53	Aug. 2015	Operational Climate Services
19.	Dec. 1995	SAARC Seminar cum Workshop on Tropical Cyclones and Forecasting (Conducted at Calcutta)	54	Dec. 2016	WMO Group Training Course "Instrument Maintenance & Calibration"
20.	Jan. 1996	LRF and Climate Change	55	March 2017	Aviation Meteorology
21.	April 1996	Mesoscale systems and circulation with special emphasis on Tropical cyclones	56	Feb. 2018	Refresher course on Interpretation of NWP products for weather forecasting services
22.	Nov. 1996	Aviation Meteorology	57	March 2018	Refresher course on Diagnostic / Synoptic Meteorology
23.	Sept. 1996	SAARC Training Workshop on Long Range Weather Forecasting and Climate Change	58	Nov. 2019	Advanced Refresher course in "Aviation Meteorology"
24.	May 2002	Aviation Meteorology	59	Dec. 2019	International Training Workshop on "Operational Climate Services"
25.	Sept. 2002	Special Refresher Course on General Meteorology for Naval Officers	60	Jan. 2020	Advanced Refresher course in "extreme Weather Events"
26.	Dec. 2002	Special Refresher Course on General Meteorology for Salt Commission Personals & salt manufacturers	61	March 2020	Training Course on "Agro-meteorology Forecasting, Translation & Dissemination"
27	April 2004	Numerical Weather Prediction	62	Nov. 2020	Advanced Refresher course in "Aviation Meteorology"
28	May 2004	Environmental Meteorology	63	Aug. 2021	Workshop (Virtual) on "Impact Based Weather Services"
29	May 2004	1st National Workshop for Port Meteorological Officer's	64	Sept. 2021	Joint IMD-RIMES training program (virtual) on Marine Meteorology
30	June 2004	Special Refresher Course on General Meteorology for Naval Officers	65	Oct 2021	Joint IMD-WMO Group Fellowship Training on "NWP
31	April 2005	1st Batch of Aviation Refresher course for SO & SA's	66	Nov. 2021	Joint IMD-RIMES training program (virtual) on Marine Meteorology
32	Sept. 2005	2nd Batch of Aviation Refresher course for SO & SA's	67	Mar. 2022	A Short-term Refresher course on "Satellite Applications for Cyclone Monitoring and Forecasting"
33	Sept. 2006	Multi-stake holder consultation workshop cum seminar on Communicating Meteorology	68	Jul. 2022	A Short-term Refresher course on "Aviation Meteorology''
34	Feb. 2007	Special Refresher Course on General Meteorology for Salt Commission Personals & salt manufacturers	69	Apr 2023	Joint IMD-WMO Group Fellowship Training on "Hands on aspects of NWP''
35	May 2007	Met. Training course for observers of Army/SASE, (Conducted at MMC Srinagar) under project PARWAT			

TABLE 2

Details of the subjects taught in different long-term training courses

Name of the Course	Duration	Subjects taught
Forecasters Training Course	6 months	Dynamic Meteorology Numerical weather Prediction Physical Meteorology Synoptic Meteorology and Aviation Meteorology Climate Science and Hydro-Meteorology Physical Oceanography & Ocean Atmosphere interaction Satellite Meteorology and Radar Meteorology Statistics and Computer programming & application
Advanced Meteorological Training Course Semester-I (All disciplines)	6 months	Observational Systems Dynamic Meteorology Physical Meteorology and Thermodynamics Oceanography & Marine Meteorology Climatology and Statistics Synoptic Meteorology including Weather Analysis and Forecasting Aviation Meteorology Hydrometeorology Environmental Meteorology Satellite and Radar Meteorology Met Telecommunication system DBM & GIS
Name of the Course	Duration	Subjects taught
Advanced Meteorological Training Course Semester-I (All disciplines)	6 months	Observational Systems Dynamic Meteorology Physical Meteorology and Thermodynamics Oceanography & Marine Meteorology Climatology and Statistics Synoptic Meteorology including Weather Analysis and Forecasting Aviation Meteorology Hydrometeorology Environmental Meteorology Satellite and Radar Meteorology Met Telecommunication system DBM & GIS
Advanced Meteorological Training Course Semester-II (General Meteorology Discipline)	6 months	Geophysical Fluid Dynamics Advanced Physical Meteorology Climate Science Advanced weather analysis & forecasting Advanced Aviation Meteorology Numerical weather prediction Physical Oceanography & Ocean-Atmosphere Interaction Advanced Statistics Computer Programming and applications Hydrometeorology

TABLE 2. ***Conti.***

Advanced Meteorological Training Course Semester-II (Meteorological instruments & communication and Information system Discipline)	6 months	Meteorological Instrumentation (Theory + Practical) Satellite Meteorology (Theory + Practical) Meteorological Telecommunication (Theory + Practical) Fortnightly – 1st half for discussion/ To attempt exercises / designated problems Weekly-2nd half for project work Preparation / finalizing / submission of project Joining + Relief + midterm exam+ final exam + viva voce Visit to DOT & IMD sections
Integrated Meteorological Training course	4 months	Observation Systems Dynamic Meteorology Numerical Weather Prediction Physical Meteorology and Marine Meteorology Synoptic Meteorology Aviation Meteorology Climatology and Statistics Satellite Meteorology Radar Meteorology Agricultural Meteorology Upper Air Instrumentation Surface Instruments Meteorological Telecommunication and Information Technology Environment Monitoring Seismology Positional Astronomy General Administration Data Base Management
Trainee Met Gr II course. Semester-I (All disciplines)	6 months	Observational Systems Dynamic Meteorology Physical Meteorology and Thermodynamics Oceanography & Marine Meteorology Climatology and Statistics Synoptic Meteorology including Weather Analysis and Forecasting Aviation Meteorology Agriculture Meteorology Hydrometeorology Seismology Astronomy Environmental Meteorology Satellite and Radar Meteorology Met Telecommunication system DBM & GIS Management
Trainee Met Gr II course. Semester-II (General Meteorology disciplines)	6 months	Geophysical fluid dynamics. Advanced Physical Meteorology. Advanced weather analysis & forecasting Advanced Aviation Meteorology

		Climate Science
		Physical Oceanography & Ocean-Atmosphere interaction
		Numerical weather Prediction
		Advanced Statistics
		Computer Programming & application
		Hydro Meteorology
		Project Work
		On the Job training
Trainee Met Gr II course. Semester-II (Agriculture Meteorology disciplines)	6 months	Overview of general agricultural meteorology
		Agromet Advisory Services for farmers
		Agromet instruments, working principles and methods of observation (including crop observations), Operation of AGRO-AWS & sensors, Methods for Soil Temperature & Moisture measurements, Validation-hands on experience
		Radiation instruments, their working principles, installation and observations, data validation– hands on experience
		Agro-Climatology of field crops
		Hydrology of soil in relation to agriculture
		Rainfall climatology for agricultural planning
		Dew, fog, humidity in relation to agriculture
		Soil and air temperature
		Evaporation, evapotranspiration, and potential evapotranspiration, crop water requirement
		Photosynthesis, radiation, and energy balance of crops
		Weather hazards affecting crops and management of Agricultural risks
		Crop phenology
		Agroclimatic classification
		Effects of temperature on crops
		Soil- water- plant relationship
		Radiation, photoperiodism and their impact on crops
		Global warming, climate change and their impact on Agriculture
		Micrometeorology
		Project work on operational agrometeorology / Agromet product generation
		Abiotic stress monitoring and management
		Principles of RS & GIS and their applications in agriculture
		Role of weather, climate on livestock production
		Working principles and methods of observation with specialized Agromet instruments
		Visit to Experimental Farms, University and SDA
		Satmet and GIS products generation for use in operational AAS
		Eddy covariance and flux measurements
		Agricultural statistics, statistical models and their applications
		Crop weather analysis and development of models
		Crop yield forecasting models
		Medium range weather forecasting and Numerical Weather Products for use in AAS

		Pest and diseases, concept of IPM and forewarning models Impact of extreme weather events on Agriculture and Disaster management Drought climatology Dryland agriculture Application of crop simulation models with special reference to DSSAT/CROPWAT/AQUACROP e-Agromet training for use in operational AAS National Natural Resource Management System (NNRMS) and monitoring of drought through Remote Sensing Operational district level AAS bulletin preparation – hands on training at PJTSAU (AMFU), Hyderabad Hands on training on weathercock, DSI, DCWC
Trainee Met Gr II course. Semester-II (Meteorological instruments and communication & information system disciplines)	6 months	Radar Technology and Radar Meteorology Communication system Meteorological instruments including hands on practice Project work On the Job training

TABLE 3

Training Calendar

Training course	Duration in months	Date of commencement	Last date of acceptance of nomination	Date of uploading in WMO GC.	Date of initiation/Planning of process.
IMTC	4	.1st working day of 2nd week of January in each year. .1st working day of 3rd week of May in each year. .1st working day of 3rd week of Sept in each year.	For overseas participants at least 10 working weeks, for national non-departmental participants at least 4 working weeks and for departmental participants at least 2 working weeks before the date of commencement of each batch of the training.	Announcement of training commencement for all batches along with other necessary details of the specific training course should be uploaded in the last week of December of the previous year.	2 months before the date of commencement of each batch of the training.
FTC & ATICIS	6	.1st working day of 2nd week of March in each year. .1st working day of 2nd week of September in each year.	For overseas participants at least 10 working weeks, for national non-departmental participants at least 4 working weeks and for departmental participants at least 2 working weeks before the date of commencement of each batch of the training.	Announcement of training commencement for all batches along with other necessary details of the specific training course should be uploaded in the last week of December of the previous year.	2 months before the date of commencement of each batch of the training.
AMTC	12	1st working day of 2nd week of September in each year.	For overseas participants at least 10 working weeks and for national non-departmental participants at least 4 working weeks before	Announcement of training commencement along with other necessary details of the specific training course should be uploaded in the last week of December of the previous year.	3 months before the date of commencement of each batch of the training.

			the date of commencement.		
Ab-initio Group-A officers training Course (Ab-initio Trainee Met-II/ Scientist-B course).	12	.1st working day of 2nd week of April in each year. .1st working day of 2nd week of July in each year. [.1st working day of 2ndweek of October in each year.	At least 2 working weeks before the date of commencement of each batch of the training.	Not applicable	3 months before the date of commencement of each batch of the training.
Orientation training	3	.1st working day of 2nd week of April in each year. .1st working day of 2nd week of July in each year. .1st working day of 2nd week of October in each year.	At least 2 working weeks before the date of commencement of each batch of the training.	Not applicable	2 months before the date of commencement of each batch of the training.
Short term customized	5 per with 1-2 weeks duration	Jan, March, May, Oct, Dec.	At least 1 working weeks before the date of commencement of each batch of the training.	Announcement of training commencement along with other necessary details of the specific training course should be uploaded 3 months before any such course	3 months before the date of commencement of each batch of the training.
Foreign trainees' course in agricultural meteorology	6 months	1st January & 1st July (as & when informed by HQ, New Delhi). Short term courses are also organized as per the demand from the countries.			
Summer placement course	4 weeks	1st week of June to last week of June.			
AMFU training course for technical officers/ nodal officers of AMFUs	2 weeks	As and when required			
Short term training course for SMS (Subject matter specialist) of DAMUs, KVK	1 week	As and when required			
Development of CRM tools for risk management in Agriculture	One week	As and when required			

used to join the Intermediate phase. Direct Recruit Scientific Assistants were imparted training comprising of the elementary and intermediate phases.

3.1.2. *Modifications*

Later, in order to comply with the WMO classification of training personnel (Class-I, II, III & IV), the methodology followed by IMD for seamless training was disintegrated into three different training programs, *viz*., Basic Training Program (WMO-Class IV training) of four months duration for Senior Observers of IMD & Observers of National Meteorological Services (NMS) from the neighbouring countries in the WMO Regional Association-II (RA-II)region, Intermediate Training Course (ITC, WMO Class-III training) of four months duration for the Scientific assistants of IMD & of NMS from the neighboring countries in the WMO RA-II region and Advanced Training Course (WMO Class-II) for the then Assistant Meteorologists and Professional Assistants of IMD. However, to cater the training needs of Group-A officers of Govt. of India departments like Indian Navy, Indian Coast Guard and that of directly recruited Forecasters of NMS from the neighbouring countries in the WMO RA-II region, the previously mentioned seamless training system was renamed as Advanced Training Course (New). This was categorized under WMO Class-II training.

Besides, when IMD started recruiting Meteorologist Grade-II (Direct recruited Group-A officers through Union

Public Service Commission), another new training course classified under WMO Class I training was developed, *viz.*, Met-II training course of one-year duration. This training had three parts, *viz*., Condensed Basic training of 2 months duration, Phase A of 4.5 months and Phase B comprising of remaining 5.5 months. Condensed basic phase was common for all disciplines (*viz.,* General Meteorology, Agricultural Meteorology and Meteorological Instrumentation & Telecommunication) covering Observational System, Meteorological Theory, Indian Climatology and Thermodynamics. Remaining phases used to be different for different disciplines.

3.1.3. *Further modification*

Since the training centers in IMD at Pune and New Delhi are functional as RTC components of WMO, classification of IMD's training needs were to be restructured following the modifications in the classification of WMO Training programs. As WMO modified the training structure into two classes, *viz*., Training for Meteorologists and Training for Meteorological technicians, IMD's training pattern was modified in the year 2009. Later, in 2009, when IMD planned to recruit Scientific Assistant directly, following the recommendation of the Syllabus Revision Committee chaired by Dr. M. Rajeevan, the previous basic and intermediate courses were merged into a single course, *viz*., Integrated Meteorological Training Course, integrating the contents from all disciplines. In 2014, following the recommendation of Syllabus Revision Committee (Dr. Kelkar Committee), tremendous changes were brought into the Met-II / Advanced Meteorological Training Course. Following the recommendations of Dr. Kelkar Committee, the Advanced Meteorological Training Course and the Met-II training course were divided into two Semesters, with Semester-I covering contents from all relevant disciplines (Forecasting, Instrument, Communication, HydroMet, Astronomy, Seismology, Satellite & Radar Meteorology and Agriculture Meteorology) and Semester-II devoted exclusively for specific disciplines (General Met, Agri. Met, Instruments & Communication and Seismology & Geophysics).

3.2. *Admission process*

Previously, the training division of IMD used to invite nominations from different stakeholders a few months before commencement of a training program. Overseas participants were informed through WMO ETR office. Every year in the last quarter, detailed information about anticipated training programs to be offered by IMD, used to be shared with WMO ETR office as a part of annual procedure. Later, when METNET, was launched as an e-governance initiative in IMD each training course is announced as a circular using the METNET platform, for inviting departmental nominations. This arrangement has brought in significant reduction in the delay in communication. For non-departmental nominations, official letters are issued. However, since a couple of years back, announcement of training programs among overseas participants is done using WMO Global Campus platform.

3.3. *Training delivery mechanisms and recent innovation brought in it*

During the initial days, training delivery was typically in Physical presence mode, using black board, chalk and duster for theory class. Occasionally slides prepared on film was also used. Later, presentation using transparency & projector, followed by MS Power Point with overhead projector were introduced in the training delivery. Considering the difficulties in sparing personnel for long term training, in e-learning was introduced in the intermediate training course for all disciplines since 2010. Entire 4 months course was segregated into two parts, *viz*., self-learning (e-learning) mode of one and half month and classroom contact mode of 2 and half months. Training resource materials used to be sent to the nominated participants by email or through uploading in the IMD's official e-governance platform METNET. Nominated trainees, being at their working place itself study the materials, consult through email with concerned resource persons for clearing doubts. During classroom contact phase, first one week used to be exhaustively utilized for clearing the doubts among trainees on the e-learning/self-study part of the course content, followed by a test to evaluate their learning. Then, portion of classroom contact phase used to be covered. Same method was applied to Forecasters Training Course (FTC) as well as Advance training in Meteorological Instrumentation, communication and Information Systems (ATMI&IS) of 6 months duration with 2 & 4 months for self-study and classroom contact phase and 1½ & 4½ months self-study and classroom contact phase respectively. This method has proved to be very effective in terms of reducing the residency period of a trainee at training center leaving his/her/their parent working place & residence. This method has been cost-effective due to substantial reduction in the per diem/ daily allowances expenditure of the sponsoring/nominating agencies/offices. IMD has introduced technology-based distance learning in its training activities, using smart electronic white board & pen, social media, Google classroom and online meeting softwares like Skype, Webex, Zoom, Google meet, *etc*. This has brought uniformity in the teaching standard across entire IMD, enhanced the number of participants, maximum utilization of potential resource persons across IMD & MoES institutes, reducing the outstation residency period of trainees & resource persons with the added

advantage of significant reduction in the cost of training delivery.

3.4. *Training evaluation process*

The prevailing practice in IMD, for training evaluation consists of three parts, *viz*., Training Examination, feedback from trainees, feedback from the nominating agencies of the trainees and feedback from the training resource persons & managers.

3.4.1. *Training examination process*

Previously, for any course, for each subject, one mid-term exam and a final written exam consisting of 30% & 70% marks respectively were conducted. Later, during 2009 when syllabus was revised, concept of internal exam in both mid-term and final examinations was introduced, with 30% marks, i.e., in the mid-term for 9% and in final for 21%. In 2014, during syllabus revision, simplicity has been brought in the examination system, by reducing the number of exams. Instead of conducting mid-term examination, 30% of the total marks of written examination is earmarked for internal assessment. Mode of testing for internal assessment consists of objective multiple-choice questions, e-test, problem-solving/puzzles, power-point presentations, practical assignments, *etc*., as deemed to be convenient/suitable.

3.4.2. *Evaluation of answer books*

There has been a significant change in the process of evaluation of training examination answer books since 2022. Earlier for each long-term certificate training course, for a given subject, one resource person was deployed for 3 different jobs, *viz*., Teaching, Setting question papers and evaluation of answer books. However, to eliminate the biasness from examination & evaluation systems, IMD has introduced 3 disjoint groups of resource persons, one for teaching/training delivery, one for setting of question papers and last one for evaluation of answer booklets of the training examinations.

Besides, during the year 2022, IMD introduced a system of centralized evaluation of training examination answer books. After the written examination is over, model answers are prepared by the designated group. The model answers are sent to different centres. Nominated evaluators at different centres are given a lead time of a few days to go through the model answers and understand the answer for each question of each paper. Then, on a fixed day, evaluation of answer books at all centres for each paper is carried out, during which all evaluators are present virtually through web-cam. On the same day score sheets from all evaluators are received centrally at MTI for further tabulation and finally declaring the results. The system of centralised evaluation has reduced the biasness in the training examination system and helped in reducing the delay in declaring the results.

3.4.2. *Training feedback mechanism*

Feedback from the trainees is obtained in the prescribed format, as given in Annexure I. Same forms are used at all training centres of IMD. The identity of the trainee providing the feedback is not obtained to ensure that both negative and positive comments are received. All the feedback data are analysed at length during the course completion meeting and genuine feedbacks / criticisms are addressed promptly with suitable suggestions for improvement.

Feedback is receipt from trainees nominated by the offices / technical divisions of IMD and other Govt. of India organisations and the National Meteorological Services of neighbouring countries in RA-II region. The feedback includes inputs about which parts of the curriculum need further elaboration with more real time and operational examples and which parts need to be retained as such. Accordingly, within the framework of the training syllabi, training curricula are made dynamic.

After completion of each and every batch of the training courses, a training completion meeting is organized between the training managers and resource persons to discuss varied technical & administrative issues faced in running the concerned batch and to decide the necessary remedial measures required for uplifting the standard of providing the training.

4. Syllabus revision process

Revision of the syllabi of different routine training courses was not done periodically in the beginning. However, since 2009 Syllabi of all routine training courses are revised within 3-5 years. Syllabi revision process is initiated after completion of 3 years of implementation of the last revised syllabi. For this, initially, subjects in different routine training courses are identified. For each such subject, 3-5 known experts, are identified to form a proposed subcommittee for a specific subject. While constituting such subcommittees, Heads of different technical divisions are consulted formally. Such subcommittees for each subject are proposed to the competent authority of IMD. After obtaining approval from the competent authority (by making necessary modifications to the proposed one), each member of the subcommittee for each subject, is approached through email along with the existing syllabi of concerned subject for different courses, with a request to revise it with

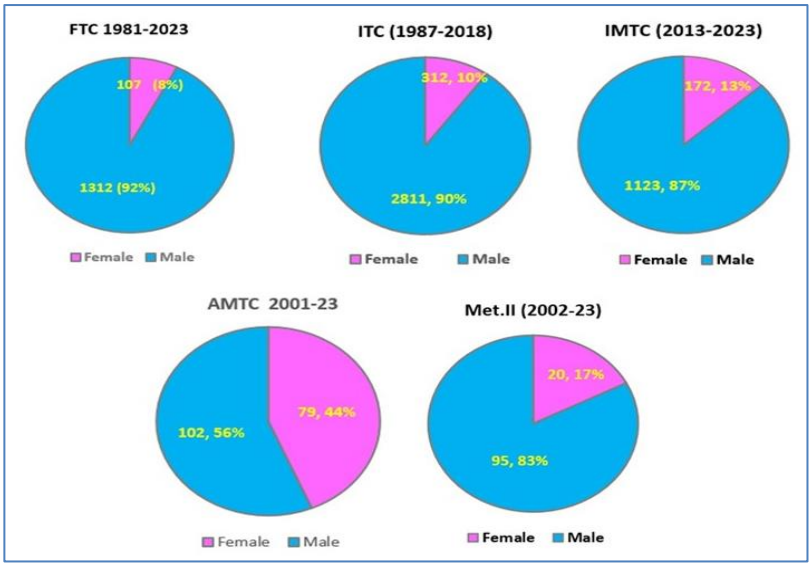

Fig. 5. The statistics of trained personnel of five courses for the periods mentioned in brackets

necessary modifications. Inputs received from each member of the subcommittee for each subject are compiled to form a consolidated proposed revised syllabus. These consolidated proposed syllabi of different subjects for different routine training courses are brainstormed by a committee for final review of training syllabi, formed by the competent authority of IMD. The final review committee brings out a report along with recommended revised syllabi of different subjects for all training courses and recommended passing/gradation of results criteria, *etc*. Recommended syllabus and other recommendations of the report are forwarded to the Director General of Meteorology (DGM), IMD for approval. DGM, IMD can approve the recommended one or may form an internal committee consisting of Heads of all technical divisions and each member may be asked for their comments on the relevant parts of the recommended syllabi. After incorporating the comments in the recommended syllabus, it is again forwarded to DGM for final approval. On receipt of DGM's approval, the final approved revised syllabi will be implemented. Latest revised syllabi (as on 2019) of all training courses have been uploaded in the website of training division https://imdpune.gov.in/training/ academics.html.

5. Faculty of the training centre

75%-80% of the trainers/resource personnel for the long-term routine training courses are trained IMD personnel. After getting departmental training, IMD personnel are utilized as training resource persons for appropriate training courses. Also, for some portions of specialized subjects like NWP, Oceanography, Atmospheric Electricity *etc*. faculties from MoES Institutes like IITM, NCMRWF, INCOIS are involved in the training programmes of IMD.

6. Statistics of trainees

The backbone of IMD has been the observational network spread across the length and breadth of the country. The functional requirement of a majority of the employees is to perform roster duties since weather observations are taken 24 x 7 in UTC timings to synchronise with the rest of the WMO member countries. The manpower in IMD has been predominantly men with a much lesser proportion of women, plausibly due to the work timings. The statistics of trained personnel of five courses for the periods mentioned in brackets, *viz*. FTC (1981-2023), ITC (1987-2018), AMTC (2001-23), IMTC (2013-23) and Met.II (2002-23) has been analysed and depicted in Fig. 5. The Male (M): Female (F) ratio of the personnel who undergo training in FTC, ITC and IMTC batches is on an average 9:1. The gender imbalance is minimum (M: 56 % , F: 44%) in the case of AMTC trainees due to a spectrum of participants from abroad and other organisations as mentioned in Para 3.1.2. In the Group A officers cadre of entry level Met.IIs, the proportion of females is 17% compared to males which is 83%.

7. Training Infrastructure

Initially there was no separate building for the training division in Pune. Condensed Basic Phase of Meteorologist Gr-II course was conducted in a tin shed hall, followed by Phases A & B in an office room at 2nd floor of Agri. Met / NDC building of Shivaji Nagar IMD office. Intermediate Training Course batches were conducted in an asbestos

shed room at Ramdurg house building of IMD Shivaji Nagar campus. Advanced Met. training Course used to be conducted at Golden Jubilee Hall near cycle stand at Shivaji Nagar campus. Later in 1993, a separate training building was constructed at Pashan, Pune near IMD Residential campus and was functional from 1996-97. This training building consisted of 4 classrooms for conducting regular training classes, an auditorium hall, a conference hall, a library, a computer laboratory, a staff room, about 10 cabins/rooms for officers and a full climatic station observatory. For the past few years, entire training building and the hostel are equipped with high speed internet connectivity, through National Knowledge Network (NKN). Training building and the hostel didn't have any power backup system. Since 2012, they are having power backup facility through 2 diesel generators. Previously, training building didn't have any NWP laboratory for hands-on practical sessions on NWP. Around 2018-19, a full-fledged NWP laboratory has been established with about 30 high end PCs connected to High Performance Computing (HPC) system through NKN.

8. Contribution towards International co-operation

MTI, Pune contributes significantly towards capacity development of overseas meteorological personnel from South Asian, African and Pacific regions, in the field of weather and climate services. The number of personnel trained in General Meteorology discipline in different levels and that of overseas personnel trained are given in Fig. 4 pictorially.

9. Recent implementation of a full-fledged technology-based distance learning in the trainings

The second semester of Batch No-180 of Advanced Meteorological Training Course (AMTC: A BIP-M training in Gen. Met. discipline) and the Batch No-8 of Integrated Meteorological Training Course (IMTC: BIP-MT) commenced in March 2020. Initially the courses started following traditional classroom contact mode. Due to worldwide COVID-19 pandemic, Govt. of India also declared countrywide lockdown except for some essential services. Then, adapting to changing needs, MTI introduced technology (from very primitive one) for continuing the training in complete distance learning mode. Teaching subjects like Geophysical Fluid Dynamics (Advanced level Dynamic Meteorology) and Numerical Weather Prediction, requires usage of conventional black board/white board writing for explanations and interpretations. Due to the crisis, entire illustration/explanation were provided through paper-written sheets scanned and shared during online Skype classes. This method was effective and connectivity issues were limited for the BIP-M, as it consisted of only 10 trainees, with 8 national participants and 2 overseas participants from Mauritius. However, when this method was attempted for IMTC, consisting of about 100 trainees, it was very difficult due to very serious connectivity issues. This problem led to the introduction of Google Classroom in training which proved effective, considering the various options available for user-friendly teaching and sharing of educational content.

9.1. *Use of Google classrooms*

Google classroom for each training program consists of many google classes for different subjects. Each google class of a specific subject is accessible to the concerned resource persons and all trainees, through their email id. All resource persons prepared their training materials in varied formats, *viz*. document/ppt/educational videos/ppts with audio illustration clipped, *etc*. and uploaded them in the concerned google classroom. Trainees are asked to go through the materials and upload their doubts/queries in the google classroom. Necessary doubts are cleared and clarifications to the queries are accordingly uploaded by the resource persons. Resource persons test the understanding/learning of the trainees *via* the internal assessment mode, by uploading assignments based on the lecture materials, which the trainees are instructed to complete and submit within a stipulated period.

9.2. *Use of social media*

For every training program, a common WhatsApp group is formed consisting of all resource personnel, training managers and all nominated/admitted trainees. This WhatsApp group is extensively used to upload all information regarding schedule/re-scheduling of training sessions, difficulties in accessing any part of google classroom, information about uploading any materials in google classroom, *etc*.

9.3. *Introduction of miniature virtual training using digital white board and web-cam*

The method of uploading training materials in the form of document/ppt/educational videos/ ppts with audio illustration clipped, *etc*., was not completely viable in fulfilling the need of face-to-face interaction. Around August 2020, digital interactive whiteboard connected with web camera has been introduced. This digital board is shared while taking online class using any platform like Google Meet, Zoom, Skype, Cisco WebEx, *etc*. This system enables explanation using white board, face-to-face interaction among remote trainees & resource persons and recording facility. Each online lecture session is recorded (video/audio both) and uploaded in the respective googles classroom. Uploaded recorded lectures are kept in the

google classroom for one week only. This arrangement enables the trainees to access the training session offline also.

10. Summary

(*i*) IMD is the pioneer in imparting meteorological education in India.

(*ii*) IMD's training establishment continues to contribute significantly towards building & strengthening the capacity of departmental, non-departmental and overseas NMHS personnel in the field of operational weather services since 1943.

(*iii*) IMD's training establishments at Pune and Delhi are functioning as two components of the Regional Training Centre of World Meteorological organization since 1988.

(*iv*) IMD organizes long term certificate training courses in the disciplines of General Meteorology, Agriculture Meteorology and Meteorological Instruments, Communication & information systems.

(*v*) IMD organizes long term certificate training courses in three broad categories, *viz*., ab-initio, career progression and orientation.

(*vi*) There is a demonstrable development with time in the different components of training service rendered by IMD.

(*vii*) About 16,000 national personnel (departmental & non-departmental), in different cadres, have been trained in the General Meteorology discipline at Meteorological Training Institute, IMD Pune till December 2020.

(*viii*) Overseas participants, numbering 286, serving in different cadres of the NMHS of about 35 countries, have been trained in the General Meteorology discipline at Meteorological Training Institute, IMD Pune till December 2020.

(*ix*) Meteorological Training Institute, IMD Pune is fully equipped with all necessary infrastructure for carrying out training activities in all modes, *viz*., only physical, only virtual and blended modes.

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Disclaimer: The contents and views presented in this research article/paper are the views of the authors and do not necessarily reflect the views of the organizations they belongs to.

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Annexure-I

FEEDBACK FORM FOR TRAINEES

Course Title : _____ **Venue :** _____

Starting Date : _____ **Duration :** _____

I. General Feedback:

Ratings by Participants on the scale of 10

10	***9***	***8***	***7***	***6***	***5***	***4***	***3***	***2***	***1***	***0***

Tick mark in relevant boxes

1. Structure of Course Content

Very Well Planned		Well Planed			Less Planed			Just OK		

2. Interaction with Faculty

Excellent		Very Good			Satisfying			Just OK		

3. Usefulness of Course

Excellent ☐ Very Good ☐ Satisfying ☐ Just OK ☐

4. Food Quality

Excellent ☐ Very Good ☐ Satisfying ☐ Just OK ☐

4. Overall Impression

Very Beneficial ☐ Beneficial ☐ Less Beneficial ☐ Not Beneficial ☐

II. Admin. Feedback:

1. Assistance provided in the Institute

Excellent ☐ Very Good ☐ Satisfying ☐ Just OK ☐

2. Infrastructure Facilities

Excellent ☐ Very Good ☐ Satisfying ☐ Just OK ☐

Your suggestions / comments for further improvements (in brief):

III. Academic Feedback:

1. Course Material

Very Useful ☐ Useful ☐ Less Useful ☐ Not Useful ☐

2. Teaching of Faculty

Excellent ☐ Very Good ☐ Good ☐ Satisfactory ☐

2a. Specific comments if any regarding teaching of faculty:

3. Hands on session (Where required)

Very Useful ☐ Useful ☐ Less Useful ☐ Not Useful ☐

4. Which topic of the subject you found:

Most Useful _____ **Least Useful** _____

The Institute is grateful for your valuable and open hearted suggestions. We would try to implement them in letter and spirit. We pray almighty for your bright and prosperous future life.

One final question:

In future if one (among your friend/colleagues) needs a meteorological training, would you recommend your department for this IMD training? (Y / N) Pl. tick mark only.

For office use only: