TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	M.Sc.	**Year/Semester:**	III
Subject:	Paleoclimatology (Dendrochronology)	**Course No.:**	Hymet 603
FullMarks:	50 (25)	**Total Period:**	30 lecture hours (15 dendro)

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
3 Class hours	Introduction	Student will be able to understand tree ring formation, how climate influence tree ring, history of dendro and various statistical parameters used in dendro study	**Contents**	**Introduction of dendrochronology**	
			Objectives	Define of tree rings, various tree rings and correlation with temperature and precipitation, ringswidth chronology, relationships between various climatic parameters, definition of various statistical parameters used in tree ring chronology	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Evaluation	History of dendrochronology, What is dendrochronology? How tree ring width is controlled by climate ?	
3 Class hours	Tree ring sampling	Student will be able to know how to get tree ring samples from field for dendroclimatic study	**Content**	**Tree ring sampling:**	
			Objective	To make familier about the tree ring sampling techniques	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual and demostration.	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt, increment borer.	
			Evaluation	Site selection and description, various methods of tree ring sampling, Description of tree ring instrument, types of borers/tree corer, definition of various statistic used in the study, the standard tree ring chronology, tree ring climate growth response	
4 Class hours	Lab measurement procedures:		**Content**	**How to measure the tree rings**	
			Objective	To make student familier about the tree ring measurement techniques	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual, and demostration.	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt, dendro lab.	
			Evaluation	Instrumental procedure used in the lab, storing the tree ring samples, data recording, sample preparation and	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
				dating methods, standardization and chronology construction	
5 Class hours	**Application of tree ring study in Meteorology**		**Content**	**Application of tree ring in Meteorology**	
			Objective	Shortout the important application of dendrochronology for meteorolgogy (dendroclimatology,dendrohydrology etc)	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt,	
			Evaluation	Relation of tree ring with temperature and other various parameters, drought and wet periods, spatial and temporal variation of tree ring climatology, long term variation of paleoclimatic condition	
15	Dendrochronology	**Learning Achievement**: At the end of the course, student will understand the importance of dendrochronology and its use for the paleo studies and able to handle the field and laboratory activities independently for paleoclimatological and paleohydrological studies			

Books:

Prescribed/ Basic Book

Tree Rings and Climate: H.C.FRITTS, ACADEMIC PRESS LONDON,NEWYORKS, AND FRANCISCO

Referrence Books:

Fundamentals of Tree ring Research: James H. Speer, The University of Arizona Press.

Dendroclimatology progess and prospect:Edits Malcolm K. Hughes, Thomas W. Swetnam, Henry F. Diaz, Springer

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Approved By

Asso. Prof. Binod Dawadi
(Subject Teacher)

Prof.Deepak Aryal
(HoD)

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	II
Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
1st (120 min)	Introduction	Student will be able to understand different type of meteorological data generation techniques, history and scope of remote sensing	**Contents**	Introduction of remote sensing	
			Objectives	To discuss a different type of meteorological data generation techniques To learn the history of remote sensing To learn the basic applications of RS To know scope and career in RS	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is meteorological data? • What are the different techniques of data acquisition? • What is remote sensing? • What are the advantages of RS?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
				• What are the basic application of remote sensing?	
			Learning Achievement	• Understand RS basics. • Distinguish between RS and in-situ observation. • Understand broad application of RS in several sectors.	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W.	

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Level:	MSc	**Year/Semester:**	II
Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
2nd			**Contents**	Introduction of satellite meteorology	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
(120 min)	Introduction of satellite meteorology (SM)	Student will be able to understand satellite meteorology	**Objectives**	To learn the history of satellite meteorology To learn the basic fields and applications of satellite meteorology To introduce satellite-based global data sets	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is satellite meteorology? • What are the different types of satellite-based global data sets? • What are the basic fields and applications of satellite meteorology? • What are the advantages of satellite meteorology?	
			Learning Achievement	• Understand satellite meteorology basics. • Understand the broad advantage of SM and in-situ observation. • Scope and career in SM.	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W. https://cimss.ssec.wisc.edu/satmet	

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Level:	MSc	**Year/Semester:**	II
Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
3rd (120 min)	Weather satellite and orbits	Student will be able to understand weather satellite and orbits	**Contents**	weather satellite and orbits	
			Objectives	To learn Satellite Orbits • Geostationary Operational Environmental Satellites (GOES) • Polar Operational Environmental Satellites (POES) To learn remote Sensing Satellite Instruments o Radiometers o Sounders	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is satellite orbits? • What are the differences between GOES and POES?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
				• What are radiometers and sounders and its applications?	
			Learning Achievement	• Understand GOES and POES. • Understand the polar and geostationary orbits? • Understand remote sensing instruments	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W. https://cimss.ssec.wisc.edu/satmet	

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Level:	MSc	**Year/Semester:**	II
Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
3rd (120 min)	Weather satellite and orbits	Student will be able to understand weather satellite and orbits	**Contents**	Weather satellite and orbits	
			Objectives	To learn satellite Images o POES Images o GOES Images To learn Math and Physics Behind Satellite Technology o Newton's Laws of Gravity o Kepler's Laws of Motion	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Distinguish POES and GOES images. • Identify different cloud type using satellite images • What are the Physics Behind Satellite Technology	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand GOES and POES images • Understand basic physics behind satellite technology	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W. https://cimss.ssec.wisc.edu/satmet	

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Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
4th (120 min)	Weather satellite and orbits	Student will be able to understand weather satellite and orbits	**Contents**	Weather satellite and orbits	
			Objectives	To learn satellite Images o POES Images o GOES Images To learn Math and Physics Behind Satellite Technology	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
				○ Newton's Laws of Gravity ○ Kepler's Laws of Motion	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Distinguish POES and GOES images. • Identify different cloud type using satellite images • What are the Physics Behind Satellite Technology	
			Learning Achievement	• Understand GOES and POES images • Understand basic physics behind satellite technology	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W. https://cimss.ssec.wisc.edu/satmet	

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Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
5th (120 min)	Electromagnetic radiation	Student will be able to understand the use of electromagnetic radiation in RS technology	**Contents**	Weather satellite and orbits	
			Objectives	To learn the electromagnetic spectrum To learn electromagnetic Waves To discuss the electromagnetic Spectrum and Radiation theory To understand how satellite radiometers "see" different sections of the Spectrum	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	What is the electromagnetic spectrum? How satellite radiometers "see" different sections of the spectrum? Discuss the electromagnetic Spectrum and Radiation theory	
			Learning Achievement	• Understand the electromagnetic spectrum and radiation theory. • Importance of electromagnetic radiation in RS technology.	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W. https://cimss.ssec.wisc.edu/satmet	

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Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
6th (120 min)	Cloud identification	The student will be able to identify clouds using satellite images	**Contents**	Cloud identification	
			Objectives	To learn physical properties and different types of clouds To identify different types of clouds using satellite images	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	What are the different types of clouds? How to distinguish different types of clouds using satellite images?	
			Learning Achievement	• Understand different types of clouds. • Understand how different types of clouds can be identify using satellite images.	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W.	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
				https://cimss.ssec.wisc.edu/satmet	

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Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
7th (120 min)	Satellite images	The student will be able to understand different types of satellite images and its application in meteorological research	**Contents**	Satellite images	
			Objectives	To learn three basic types of satellite images (visible, infrared, and water vapor). To learn how to identify basic cloud types and storm systems in satellite images. To demonstrate the basic knowledge necessary to interpret satellite observations	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual, Online satellite image visualization system	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt, Internet, Online satellite images	
			Evaluation	What are the types of satellite images? How to identify basic cloud types and storm systems in satellite images?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand visible, infrared, and water vapor images. • Identify basic cloud types and storm systems in satellite images. • Interpret satellite observations	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W. https://cimss.ssec.wisc.edu/satmet	

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Level:	MSc	**Year/Semester:**	II
Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
8th (120 min)	Monitor global environment	The student will be able to understand how satellite observation can be used to monitor the global environment	**Contents**	Monitor global environment	
			Objectives	To learn how geostationary satellites are used to detect forest fires & monitor biomass burning To learn the connection between biomass burning and global warming Use of satellite images to identify Urban Heat Islands To learn the use of satellite observation in disaster risk reduction and management. To learn NDVI	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual, Online satellite image visualization system	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt, Internet, Online satellite images	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Evaluation	How geostationary satellites are used to detect forest fires & monitor biomass burning What is the connection between biomass burning and global warming Explain the application of satellite observation in different types of disaster risk reduction/management	
			Learning Achievement	Understand how geostationary satellites are used to detect forest fires & monitor biomass burning Understand how useful satellite observations are in disaster risk reduction/management	
			Prescribed/ Basic Book	Remote sensing and Image Interpretation. Lillesand, T. M. and Kiefer, R. W. https://cimss.ssec.wisc.edu/satmet	

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Level:	MSc	**Year/Semester:**	II
Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
9th (6 hours) Practical class	Analysis of Satellite images	The student will be able to analyze satellite images	**Contents**	Analysis of satellite images	
			Objectives	To understand different geostationary satellite products that cover Nepal region (INSAT, FY2E/F, HIMAWARI, METEOSAT)	
			Teaching Methods	Audiovisual, practical	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt, Internet, computer lab	
			Evaluation	Analyze images from different geostationary satellites Prepare animation of visible images over Nepal domain. Track thunder cloud direction and identify potential area of heavy rainfall	
			Learning Achievement	Demonstrate how online visualization platform can be used for satellite observation	
			Prescribed/ Basic Book	https://giovanni.gsfc.nasa.gov/giovanni/	

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Level:	MSc	**Year/Semester:**	II
Subject:	Remote sensing and Disaster	**Course No.:**	Hymet 556
Full Marks:	50	**Total Period:**	45 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
10th (6 hours) Practical class	Analysis of satellite data	The student will be able to handle GEOVANNI online visualization platform	**Contents**	Analysis of satellite data	
			Objectives	To learn different satellite products (TRMM, GPM, MODIS, sentinel etc). To analysis different meteorological parameters obtained from satellite observation using GEOVANNI online visualization platform.	
			Teaching Methods	Audiovisual, Online satellite image visualization system (GEOVANNI)	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt, Internet, computing lab	
			Evaluation	Prepare precipitation map over Nepal using IMERG-GPM satellite date Plot time monthly series of precipitation over Nepal from 2000 to 2019	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
				Plot hovmoller diagram of temperature, pressure and humidity at 85 degrees east longitude	
			Learning Achievement	Demonstrate the ability of different satellite images for real-time weather observations.	
			Prescribed/ Basic Book	https://giovanni.gsfc.nasa.gov/giovanni/	

Subject Teacher: Dr. Dibas Shrestha

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Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
1st (60 mins)	Atmospheric Boundary Layer	Student will be able to understand micrometeorology and its scope; energy balance at the earth-atmosphere boundary	**Contents**	Introduction and scope of micrometeorology	
			Objectives	To understand micrometeorology To understand scope of micrometeorology	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is micrometeorology? • What are the scopes of micrometeorology?	
			Learning Achievement	• Understand micrometeorology • Understand scope of micrometeorology	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
2nd (60 mins)	Atmospheric Boundary Layer	Student will be able to understand micrometeorology and its scope; energy balance at the earth-atmosphere boundary	**Contents**	Energy balance at the earth-atmosphere boundary	
			Objectives	To learn the energy balance at the earth-atmosphere boundary	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• How is the energy balanced at the earth-atmosphere boundary?	
			Learning Achievement	• Understand the energy balance at the earth-atmosphere boundary	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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(Subject Teacher) (HoD)

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Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
3rd (60 mins)	Atmospheric Boundary Layer	Student will be able to understand micrometeorology and its scope; energy balance at the earth-atmosphere boundary	**Contents**	Relation between micrometeorology and microclimatology, applications of models in micrometeorological study	
			Objectives	To understand the relation between micrometeorology and microclimatology To learn the applications of models in micrometeorological study	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is the relation between micrometeorology and microclimatology? • What are three main purpose that serve the model in micrometeorology?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand the relation between micrometeorology and microclimatology • Understand the applications of models in micrometeorological study	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
4th (60 mins)	Energy Balance at the Earth's surface	Student will be able to understand spectrum of radiation, effect of temperature on radiant energy, solar energy at	**Contents**	Spectrum of radiation	
			Objectives	To understand the spectrum of radiation	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		the outer boundary of the atmosphere, depletion of solar energy by the atmosphere, optical air mass; reflection, scattering and albedo of earth's surface.	**Evaluation**	• What is the spectrum of radiation?	
			Learning Achievement	• Understand the spectrum of radiation	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
5th (60 mins)	Energy Balance at the Earth's surface	Student will be able to understand spectrum of radiation, effect of temperature on radiant energy, solar energy at the outer boundary of the atmosphere, depletion of solar energy by the atmosphere, optical air mass; reflection, scattering and albedo of earth's surface.	**Contents**	Effect of temperature on radiant energy	
			Objectives	To understand the effect of temperature on radiant energy	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the effects of temperature on radiant energy?	
			Learning Achievement	• Understand the effect of temperature on radiant energy	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
6th and 7th (120 mins)	Energy Balance at the Earth's surface	Student will be able to understand spectrum of radiation, effect of temperature on radiant energy, solar energy at the outer boundary of the atmosphere, depletion of solar energy by the atmosphere, optical air mass; reflection, scattering and	**Contents**	Solar energy at the outer boundary of the atmosphere, Depletion of solar energy by the atmosphere	
			Objectives	To understand the solar energy at the outer boundary of the atmosphere, To understand the depletion of solar energy by the atmosphere	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• How are energy balanced at the earth's atmosphere boundary? • How is solar energy depleted by the atmosphere?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		albedo of earth's surface.	**Learning Achievement**	• Understand the energy balanced at the earth's atmosphere boundary • Understand the depletion of solar energy by the atmosphere	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
8th (60 mins)	Energy Balance at the Earth's surface	Student will be able to understand spectrum of radiation, effect of temperature	**Contents**	Optical air mass; reflection, scattering and albedo of earth's surface	
			Objectives	To understand the optical air mass; reflection, scattering and albedo of earth's surface	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		on radiant energy, solar energy at the outer boundary of the atmosphere, depletion of solar energy by the atmosphere, optical air mass; reflection, scattering and albedo of earth's surface.	**Teaching Methods**	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is optical air mass? • What are the effects of reflection, scattering and albedo of the earth's surface?	
			Learning Achievement	• Understand optical air mass • Understand the effect of reflection, scattering and albedo of the earth's surface	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
9th and 10th (120 mins)	Radiation process on the Earth's surface	Student will be able to understand the definition of emissivity and laws of radiation, short wave radiation measurement, long wave radiation from the earth's surface, net radiation and its estimation, evaporation from the earth's surface, sensible heat flux and its estimation, precipitation heat flux and its measurement, soil temperature and its characteristics, ground heat flux and its determination, definition and calculation of thermal conductivity and thermal diffusivity of the soil layer, soil heat transformation: Fourier heat conduction theory.	**Contents**	Definition of emissivity and laws of radiation, short wave radiation measurement, long wave radiation from the earth's surface, net radiation and its estimation, evaporation (latent heat flux) from the earth's surface	
			Objectives	To understand the emissivity and laws of radiation To understand , short wave radiation and its measurement To understand long wave radiation from the earth's surface To understand net radiation and its estimation To understand evaporation from the earth's surface	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Explain emissivity and laws of radiation • How is short wave radiation measured? • Discuss on the long wave radiation from the earth's surface. • How is the net radiation estimated? • Discuss on the evaporation from the earth's surface	
			Learning Achievement	• Understand emissivity and laws of radiation • Understand , short wave radiation and its measurement • Understand long wave radiation from the earth's surface • Understand net radiation and its estimation • Understand evaporation from the earth's surface	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
11th and 12th (120 mins)	Radiation process on the Earth's surface	Student will be able to understand the definition of emissivity and laws of radiation, short wave radiation measurement, long wave radiation from the earth's surface, net radiation and its estimation, evaporation from the earth's surface, sensible heat flux and its estimation,	**Contents**	Sensible heat flux and its estimation, precipitation heat flux and its measurement, soil temperature and its characteristics, ground heat flux and its determination	
			Objectives	To understand the sensible heat flux and its estimation To understand the precipitation heat flux and its measurement To understand emissivity and laws of radiation To understand the soil temperature and its characteristics To understand the ground heat flux and its determination	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		precipitation heat flux and its measurement, soil temperature and its characteristics, ground heat flux and its determination, definition and calculation of thermal conductivity and thermal diffusivity of the soil layer, soil heat transformation: Fourier heat conduction theory.	**Materials**	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• How do we estimate sensible heat flux? • How do we measure precipitation heat flux? • Explain emissivity and laws of radiation. • What are the characteristics of soil temperature? • How do we determine ground heat flux?	
			Learning Achievement	• Understand the sensible heat flux and its estimation • Understand the precipitation heat flux and its measurement • Understand emissivity and laws of radiation • Understand the soil temperature and its characteristics • Understand the ground heat flux and its determination	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
13th (60 mins)	Radiation process on the Earth's surface	Student will be able to understand the definition of emissivity and laws of radiation, short wave radiation measurement, long wave radiation from the earth's surface, net radiation and its estimation, evaporation from the earth's surface, sensible heat flux and its estimation, precipitation heat	**Contents**	Definition and calculation of thermal conductivity and thermal diffusivity of the soil layer, soil heat transformation: Fourier heat conduction theory.	
			Objectives	To understand definition and calculation of thermal conductivity and thermal diffusivity of the soil layer To understand soil heat transformation: Fourier heat conduction theory	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Explain about the heat transfer in the solid surface. • Derive the Fourier heat conduction equation.	
			Learning Achievement	• Understand definition and calculation of thermal conductivity and thermal diffusivity of the soil layer	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		flux and its measurement, soil temperature and its characteristics, ground heat flux and its determination, definition and calculation of thermal conductivity and thermal diffusivity of the soil layer, soil heat transformation: Fourier heat conduction theory.		• Understand soil heat transformation • Understand Fourier heat conduction theory	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
14th (60 mins)	Atmospheric elements over homogenous surface	Student will be able to understand Monin Obukhov and Richardson number and their use, friction velocity and roughness length, viscosity, drag coefficient, surface shearing stress and wind shear, definition and determination of bulk coefficient and momentum eddy diffusivity, mean wind and vertical wind profile in the absence of buoyancy as well as in a non-adiabatic	**Contents**	Monin Obukhov and Richardson number and their use	
			Objectives	To understand the Monin Obukhov and Richardson number and their use	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Describe the Monin Obukhov and Richardson number.	
			Learning Achievement	• Understand Monin Obukhov and Richardson number and their use	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		atmosphere, viscous dissipation and adiabatic wind profile, eddy correlation method for measuring turbulent heat fluxes.			

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
15th, 16th and 17th (180 mins)	Atmospheric elements over homogenous surface	Student will be able to understand Monin Obukhov and Richardson number and their use, friction velocity and roughness length, viscosity, drag coefficient, surface shearing stress and wind shear, definition and determination of bulk coefficient and momentum eddy diffusivity, mean wind and vertical wind profile in the absence of buoyancy as well as	**Contents**	Friction velocity and roughness length, viscosity, drag coefficient, surface shearing stress and wind shear, definition and determination of bulk coefficient and momentum eddy diffusivity	
			Objectives	To understand the friction velocity and roughness length To understand the viscosity, drag coefficient, surface shearing stress and wind shear To understand the definition and determination of bulk coefficient and momentum eddy diffusivity	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		in a non-adiabatic atmosphere, viscous dissipation and adiabatic wind profile, eddy correlation method for measuring turbulent heat fluxes.	**Evaluation**	• Define friction velocity and roughness length. • Describe viscosity, drag coefficient, surface shearing stress and wind shear • Describe bulk coefficient and momentum eddy diffusivity	
			Learning Achievement	• Understand the friction velocity and roughness length • Understand the viscosity, drag coefficient, surface shearing stress and wind shear • Understand bulk coefficient and momentum eddy diffusivity	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
18th, 19th and 20th (180 mins)	Atmospheric elements over homogenous surface	Student will be able to understand Monin Obukhov and Richardson number and their use, friction velocity and roughness length, viscosity, drag coefficient, surface shearing stress and wind shear, definition and determination of bulk coefficient and momentum eddy diffusivity, mean wind and vertical wind profile in the absence of buoyancy as well as	**Contents**	Mean wind and vertical wind profile in the absence of buoyancy as well as in a non-adiabatic atmosphere, viscous dissipation and adiabatic wind profile, eddy correlation method for measuring turbulent heat fluxes	
			Objectives	To understand the mean wind and vertical wind profile in the absence of buoyancy as well as in a non-adiabatic atmosphere To understand viscous dissipation and adiabatic wind profile To understand eddy correlation method for measuring turbulent heat fluxes	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		in a non-adiabatic atmosphere, viscous dissipation and adiabatic wind profile, eddy correlation method for measuring turbulent heat fluxes.	**Evaluation**	• Describe the equation of vertical wind profile in the absence of buoyancy • Describe the viscous dissipation and adiabatic wind profile • Describe the eddy correlation method for measuring turbulent heat fluxes	
			Learning Achievement	• Understand the mean wind and vertical wind profile in the absence of buoyancy as well as in a non-adiabatic atmosphere • Understand the viscous dissipation and adiabatic wind profile • Understand eddy correlation method for measuring turbulent heat fluxes	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
21st and 22nd (120 mins)	Turbulence and wind flow over homogeneous surface	Nature and causes of the turbulence, spectrum of turbulence, Kolmogorov's similarity theory and its application, dimensional analysis and similarity theory, measurement process of different parameters/coefficients in turbulence, local wind flows in valleys and cities, wind flow around cylindrical and irregular objectives, wind flow profiles over	**Contents**	Nature and causes of the turbulence, spectrum of turbulence, Kolmogorov's similarity theory and its application, dimensional analysis and similarity theory	
			Objectives	To understand the nature and causes of the turbulence To understand the spectrum of turbulence To understand the Kolmogorov's similarity theory and its application To understand the dimensional analysis and similarity theory	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		a canopy, plant cover or forest, temperature and humidity over the water surface.	**Materials**	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Describe the nature and cause of turbulence. • Describe the Kolmogorov similarity theory. • Describe the dimensional analysis and similarity theory.	
			Learning Achievement	• Understand the nature and causes of the turbulence • Understand the spectrum of turbulence • Undrestand the Kolmogorov's similarity theory and its application • Understand the the dimensional analysis and similarity theory	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
23rd and 24th (120 mins)	Turbulence and wind flow over homogeneous surface	Nature and causes of the turbulence, spectrum of turbulence, Kolmogorov's similarity theory and its application, dimensional analysis and similarity theory, measurement process of different parameters/coefficients in turbulence, local wind flows in valleys and cities, wind flow around cylindrical and irregular objects, wind flow profiles over a canopy, plant cover or forest, temperature and humidity over the	**Contents**	Measurement process of different parameters/coefficients in turbulence, local wind flows in valleys and cities, wind flow around cylindrical and irregular objects	
			Objectives	To understand the measurement process of different parameters/coefficients in turbulence To understand the local wind flows in valleys and cities, wind flow around cylindrical and irregular objects	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Describe the measurement process of different parameters in turbulance.	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		water surface.		• Describe the local wind flows in valleys and cities. • Describe the wind flow around cylindrical and irregular objects.	
			Learning Achievement	• Understand the measurement process of different parameters/coefficients in turbulence • Understand the local wind flows in valleys and cities • Undrestand the wind flow around cylindrical and irregular objects	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
25th (60 mins)	Turbulence and wind flow over homogeneous surface	Nature and causes of the turbulence, spectrum of turbulence, Kolmogorov's similarity theory and its application, dimensional analysis and similarity theory, measurement process of different parameters/coefficients in turbulence, local wind flows in valleys and cities, wind flow around cylindrical and irregular objectives, wind flow profiles over a canopy, plant cover	**Contents**	Wind flow profiles over a canopy, plant cover or forest, temperature and humidity over the water surface.	
			Objectives	To understand the wind flow profiles over a canopy, plant cover or forest To understand the temperature and humidity over the water surface.	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Explain the wind flow profiles over a canopy • Explain the wind flow profiles over a plant cover • Explain the wind flow profiles over a forest	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		or forest, temperature and humidity over the water surface.	**Learning Achievement**	• Understand the wind flow profiles over a canopy, plant cover or forest • Understand the temperature and humidity over the water surface	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
26th and 27th	Micrometeorological elements within the forest	Air temperature, canopy temperature, soil temperature, wind	**Contents**	Air temperature, canopy temperature, soil temperature, wind velocities and humidity in the plant cover	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
(120 mins)		velocities and humidity in the plant cover, energy balance of a forest and lake surface, heat storage and transformation in the forest, energy balance component within the plant cover.	**Objectives**	To understand the air temperature in the plant cover To understand the canopy temperature in the plant cover To understand the soil temperature in the plant cover To understand the wind velocities and humidity in the plant cover	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Explain the air temperature in the plant cover. • Explain the canopy temperature in the plant cover. • Expalin the soil temperature in the plant cover • Explain the wind velocities and humidity in the plant cover.	
			Learning Achievement	• Understand the air temperature, canopy temperature, soil temperature, wind velocities and humidity in the plant cover	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

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Level:	MSc	**Year/Semester:**	II
Subject:	Micrometeorology	**Course No.:**	Hymet 552
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
28th, 29th and 30th (180 mins)	Micrometeorological elements within the forest	Air temperature, canopy temperature, soil temperature, wind velocities and humidity in the plant cover, energy balance of a forest and lake surface, heat storage and transformation in the forest, energy balance component within the plant cover.	**Contents**	Energy balance of a forest and lake surface, heat storage and transformation in the forest, energy balance component within the plant cover.	
			Objectives	To understand the energy balance of a forest and lake surface To understand the heat storage and transformation in the forest To understand the energy balance component within the plant cover	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Evaluation	• Explain the energy balance of a forest. • Explain the energy balance of a lake surface. • Explain the heat storage and transformation in the forest. • Explain the temperature in the plant cover. • Explain the energy balance component within the plant cover.	
			Learning Achievement	• Understand the the energy balance of a forest and lake surface • Understand the heat storage and transformation in the forest • Understand the energy balance component within the plant cover	
			Prescribed/ Basic Book	Munn, R. E., Descriptive Micrometeorology, 1966	

Prepared By: Dr. Sunil Acharya
(Subject Teacher)

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TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
1st (60 mins)	Isotope study	Introduction of stable isotopes, definition, fundamental composition of stable isotopes, Standard Mean Ocean Water(SMOW) and Vienna Standard Mean Ocean Water(V-SMOW), relative abundances of hydrogen and oxygen isotopes, historical records of stable isotopes in Nepal,	**Contents**	Introduction of stable isotopes, definition, fundamental composition of stable isotopes	
			Objectives	To understand stable isotopes	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are stable isotopes? • Discuss on the relative abundance of stable water isotopes.	
			Learning Achievement	• Understand stable water isotopes	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		IAEA,GNIP and TNIP data interpretation		Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

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Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
2nd (60 mins)	Isotope study	Introduction of stable isotopes, definition, fundamental composition of stable isotopes, Standard Mean Ocean	**Contents**	Standard Mean Ocean Water (SMOW) and Vienna Standard Mean Ocean Water (V-SMOW), relative abundances of hydrogen and oxygen isotopes	
			Objectives	To understand Standard Mean Ocean Water (SMOW) and Vienna Standard Mean Ocean Water (V-SMOW)	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		Water(SMOW) and Vienna Standard Mean Ocean Water(V-SMOW), relative abundances of hydrogen and oxygen isotopes, historical records of stable isotopes in Nepal, IAEA,GNIP and TNIP data interpretation		To understand relative abundances of hydrogen and oxygen isotopes	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are SMOW and VSMOW? • Discuss on the relative abundance of hydrogen and oxygen isotopes	
			Learning Achievement	• Understand SMOW and VSMOW • Understand relative abundances of hydrogen and oxygen isotopes	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

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Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
3rd (60 mins)	Isotope study	Introduction of stable isotopes, definition, fundamental composition of stable isotopes, Standard Mean Ocean Water(SMOW) and Vienna Standard Mean Ocean Water(V-SMOW), relative abundances of hydrogen and oxygen isotopes, historical records of stable isotopes in Nepal, IAEA,GNIP and TNIP data interpretation	**Contents**	Historical records of stable isotopes in Nepal, IAEA,GNIP and TNIP data interpretation	
			Objectives	To understand historical records of stable isotopes in Nepal To interpretate IAEA,GNIP and TNIP data	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Discuss on historical records of stable isotopes in Nepal. • Interpretate the given GNIP datasets.	
			Learning Achievement	• Understand historical records of stable isotopes in Nepal • Understand the data interpretation from GNIP datasets	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
4th and 5th (120 mins)	Measurement of stable isotopes	Precipitation and water isotopes sample collection and laboratory measurement, precipitation and rain water samples, river water stable isotopes, precipitation water samples collection procedures, laboratory analysis and isotope data recording	**Contents**	Precipitation and water isotopes sample collection and laboratory measurement, precipitation and rain water samples, river water stable isotopes, precipitation water samples collection procedures, laboratory analysis and isotope data recording	
			Objectives	To understand the procedure of river and precipitation sample collection To understand the procedure of laboratory analysis	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the procedures to collect river/precipitation water sample collection? • How are samples analysed in the laboratory? • Why are internal laboratory standards (ILS) necessary?	
			Learning Achievement	• Understand the procedure of river and precipitation sample collection • Understand the procedure of laboratory analysis	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

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Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
6th 7th and 8th (120 mins)	Estimation methods	Estimation of stable isotopes using Araguas, Craig and Dansgaard equations, also using some theoretical aspects empirical relations	**Contents**	Estimation of stable isotopes using Araguas, Craig and Dansgaard equations, also using some theoretical aspects empirical relations	
			Objectives	To understand the estimation of stable isotopes using Araguas, Craig and Dansgaard equations To understand the estimation of stable isotopes using empirical relations	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Estimate the stable isotopes using Araguas, Craig and Dansgaard equations. • Estimate the stable isotopes using empirical formulas.	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand the estimation of stable isotopes using Araguas, Craig and Dansgaard equations. • Understand the estimation of stable isotopes using some empirical formulas.	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

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Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
9th (60 mins)	Meteoric water lines	Definition of meteoric water line, local and	**Contents**	Definition of meteoric water line, local and global meteoric water lines, Craig's meteoric water line	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		global meteoric water lines, Craig's meteoric water line, definition of deuterium excess and its calculation, difference between precipitation and river water isotopes, altitude variation of stable isotopes.	**Objectives**	To understand Global Meteoric Water Line (GMWL) and Local Meteoric Water Lines (LMWL)	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is GMWL? • What is LMWL? • What do the slopes and intercepts of MWL indicate?	
			Learning Achievement	• Understand GMWL and LMWL	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

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Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603

Full Marks: 50	**Total Period:** 30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
10th (60 mins)	Meteoric water lines	Definition of meteoric water line, local and global meteoric water lines, Craig's meteoric water line, definition of deuterium excess and its calculation, difference between precipitation and river water isotopes, altitude variation of stable isotopes.	**Contents**	definition of deuterium excess and its calculation	
			Objectives	To understand deuterium excess (d-excess)	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is d-excess? • How is d-excess calculated? • What are the factors affecting d-excess? • What does d-excess value indicate regarding atmospheric circulation?	
			Learning Achievement	• Understand d-excess	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

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Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
11th (60 mins)	Meteoric water lines	Definition of meteoric water line, local and global meteoric water lines, Craig's meteoric water line, definition of deuterium excess and its calculation, difference between precipitation and river water isotopes, altitude variation of stable isotopes.	**Contents**	Difference between precipitation and river water isotopes, altitude variation of stable isotopes	
			Objectives	To understand the difference between precipitation and river water isotopes To understand altitude variation of stable isotopes	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the difference between precipitation and river water isotopes? • What is altitude effect?	
			Learning Achievement	• Understand the difference between precipitation and river water isotopes • Understand the altitude effect	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

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Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
12th and 13th (120 mins)	Amount and temperature effects	Amount effect and its application, correlation with precipitation and temperature, relationships of stable isotopes with precipitation and temperature, the long term trends of temperature and precipitation.	**Contents**	Amount effect and its application, correlation with precipitation and temperature, relationships of stable isotopes with precipitation and temperature, the long term trends of temperature and precipitation.	
			Objectives	To understand the amount effect and the temperature effect and their application To understand the trend of temperature effect and amount effect	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is amount effect? • What is temperature effect? • What is the trend of temperature effect and amount effect?	
			Learning Achievement	• Understand the temperature effect and the amount effect • Understand the trend of temperature effect and amount effect	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

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Approved By

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

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Level:	MSc	**Year/Semester:**	III
Subject:	Paleo-climatology (Isotope studies)	**Course No.:**	Hymet 603
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
14th and 15th (120 mins)	Importance of stable isotopes studies	Application of stable isotopes on local and regional precipitation, tracking of monsoon precipitation, air mass system and circulation process, seasonal, temporal and spatial variation of isotopes, Paleo	**Contents**	Application of stable isotopes on local and regional precipitation, tracking of monsoon precipitation, air mass system and circulation process, seasonal, temporal and spatial variation of isotopes, Paleo climate and stable isotopes	
			Objectives	To understand the application of stable isotopes on local and regional precipitation To understand tracking of monsoon precipitation, air mass system and circulation process using water isotopes To understand temporal and spatial variation of isotopes To understand reconstruction of Paleoclimate using stable isotopes	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		climate and stable isotopes.	**Teaching Methods**	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the application of stable isotopes? • How is paleoclimate reconstructed using application of stable isotopes? • How is monsoon evolution and onset identified using stable isotopes in precipitation?	
			Learning Achievement	• Understand the application of stable water isotopes	
			Prescribed/ Basic Book	Environmental Isotopes in the Hydrological Cycle, IAEA Clark, I., Fritz, P., Environmental isotopes in hydrogeology. Lewis Publishers, Boca Raton, Fla (1997).	

Prepared By: Dr. Sunil Acharya
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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
1st (120 min)	Air mass	Student will be able to understand air mass classifications, source regions, modification and associated weather	**Contents**	Air mass classifications, source regions, modification and associated weather,	
			Objectives	• To familiarize the students with air mass and different source regions of air mass • To understand air mass modification mechanism and associated weather	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is air mass? • What are different sources of air mass regions? • What are the air mass modification mechanisms?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand concept of air mass • Understand different types of air mass source regions • Understand the classification process of air mass associated weather	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
2nd (120 min)	Air mass	Student will be able to understand extra- tropical cyclones, their origin and associated weather.	**Contents**	Extra- tropical cyclones, their origin and associated weather	
			Objectives	• To familiarize the students with origin of cyclone and extra-tropical cyclone • To familiarize the students with Weather associated with cyclone and extra tropical cyclone	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are differences in tropical and extra tropical weather? • What are disasters due to extra tropical weather?	
			Learning Achievement	• Understand concept of extra-tropical cyclones	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
				• Understand type of weather associated with extra- tropical cyclones on the globe	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

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Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDHM)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
3rd (120 min)	Convective cloud and weather	Student will be able to understand Vertical acceleration, stability criteria, classification of sounding	**Contents**	Vertical acceleration, stability criteria, classification of sounding,	
			Objectives	• To familiarize the students with vertical acceleration • To familiarize the students with Stability criteria on the atmosphere and environment • To understand the classification of sounding,	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is vertical acceleration • What is condition for stability? • How different instability recognized? • How soundings are classified?	
			Learning Achievement	• Understand concept of vertical acceleration • Understand different type of instability condition in the atmosphere • Understand the classification of soundings	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
4th (120 min)	Convective cloud and weather	Student will be able to understand Intrainment, Thunderstorm, Thunderstorm guests	**Contents**	Intrainment, Thunderstorm, Thunderstorm guests	
			Objectives	• To learn the intrainment process on the atmosphere • To learn the thunderstorm process, life cycle • To know the thunderstorm guest phenomena	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is intrainment process on the atmosphere? • What are life cycle of thunderstorm and thunderstorm guests? • What are the differences between thunderstorm and thunderstorm guest?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand intrainment process • Understand the differences between thunderstorm and thunderstorm gusts .	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956	

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Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
5th (120 min)	Convective cloud and weather	Student will be able to understand Hailstorms,	**Contents**	Hailstorms, local weather warnings	
			Objectives	To learn Hailstorms • How it forms • Characteristics of it	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
		local weather warnings		To learn local weather warnings • Forecast with different statistical methods	
			Teaching Methods	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are Hailstorms? • How local weather are forecasting?	
			Learning Achievement	• Understand hailstorms, • Understand local weather warnings • Understand the weather forecasting methodology.	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956	

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Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
6th (120 min)	Global Wind System	Student will be able to understand General circulation, single and three cell model	**Contents**	General circulation, single and three cell model	
			Objectives	To learn circulation pattern of air mass • General circulation • Controlling factors To learn Three cell model • Familiar with zonal circulation • Vertical circulation, • How air mass travel in different altitude and latitude.	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the factors for circulation of air mass? • How air mass circulation in different cells? • How Energy is transferred?	
			Learning Achievement	• Understand Circulation of air mass • Understand basic principles of three cell model phenomena.	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
7th (120 min)	Weather satellite and orbits	Student will be able to understand Elnino-southern oscillation	**Contents**	Elnino-southern oscillation	
			Objectives	• To learn Southern oscillation • Pressure differences. • Sea level temperature • Periodity of occurrence • To learn anomaly of SSt and rainfall variability in different parts of Globe • Effects on National economy due to Elnino	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• Understand of SOI • How Elnino and non Elnino years are identified? • What are the correlation between SST and Rainfall	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand southern oscillation phenomena • Understand basic SST variability in Elnino and non Elnino years	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
8th (120 min)	Middle and high latitude weather system	Student will be able to understand the Jet streams, their classification and characteristics	**Contents**	Jet streams, their classification and characteristics	
			Objectives	• To learn the jet streams • To identify the different type of jet streams • To understand the classification of jet streams • To understand the winter and summer characteristics of jet streams	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the jet streams? • Where jet streams are found? • How jet streams are classified? • How differentiate characteristics of jet streams in winter and summer seasons?	
			Learning Achievement	• Understand jet streams concept, types and characteristics of jet streams	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDMH)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
9th (120 min)	Middle and high latitude weather system	The student will be able to understand Asian monsoon, associated weather	**Contents**	Asian monsoon, associated weather	
			Objectives	• To learn Asian monsoon • Formation mechanism of monsoon • To know the importance of Asian monsoon.	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is monsoon and how it is play important role in Asia? • What are the onset dates of monsoon in Asia? • What are the causes of monsoon variability?	
			Learning Achievement	• Understand different season's rainfall Variability. • Understand weather associated with atmospheric phenomena • Understand cyclone,anticyclones	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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TEACHING PLAN

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Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
10th (120 min)	Synoptic component of the monsoon	The student will be able to understand role of ITCZ on monsoon circulation ,easterly waves, near equatorial monsoon trough	**Contents**	Role of ITCZ on monsoon circulation, easterly waves, near equatorial monsoon trough,	
			Objectives	• To understand importance of ITCZ • To learn effects on ITCZ on SW monsoon circulation system • To understand the monsoon trough	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt,	
			Evaluation	• What are the importances of ITCZ on SW monsoon system? • What is monsoon trough how it shifts?	
			Learning Achievement	• Understand role of ITCZ on SW monsoon circulation. • Monsoon trough ,easterly waves	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDMH)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
11th (120 min)	Synoptic component of the monsoon	The student will be able to understand squall lines in the monsoon area, planetary scale monsoons, corresponding elements of winter and summer monsoon	**Contents**	Squall lines in the monsoon area, planetary scale monsoons, corresponding elements of winter and summer monsoon.	
			Objectives	• To learn squall lines in the monsoon area • To learn planetary scale monsoons circulation system • To understand the Variability of rainfall due to effect of planetary circulation system • To understand the Variability of winter and summer monsoon in Asia.	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What is the effect on monsoon variability due to planetary scale monsoon circulation?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
				• How winter and monsoon rainfall variability occurred on the globe?	
			Learning Achievement	• Understand squall lines in the monsoon area • Understand planetary scale monsoons, corresponding elements of winter and summer monsoon.	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDMH)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
12th (120 min)	Synoptic component of the monsoon	The student will be able to The easterly jet stream different component of SW Indian monsoon	**Contents**	The easterly jet stream, different component of SW Indian monsoon.	
			Objectives	• To understand the easterly jet stream and its characteristics • To understand different component of SW Indian Monsoon • To understand On set, with drawl dates of South Asian country. Monsoon Variability	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt,	
			Evaluation	• What are the easterly jet streams and how it effects on SW monsoon? • What is the onset and withdrawal dates of SW monsoon?	
			Learning Achievement	• Understand SW Asian monsoon and its importance in south Asia. • Understand effects of jet streams on SW monsoon	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDMH)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
13th (120 min)	Precipation and mesoscale feature of the monsoon	Student will be able to understand general features of monsoon rainfall, heat low, monsoon depressions	**Contents**	General features of monsoon rainfall, heat low, monsoon depressions,	
			Objectives	• To understand features of monsoon(Variability) • To learn heat low and associated weather • To understand monsoon depression mechanism	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the feathers of summer monsoon? • What are the favorable conditions for heat low? • How SW monsoon are depressed?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand monsoon feathers variability • Understand heat low and monsoon depression mechanism	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDMH)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
14th (120 min)	Precipation and mesoscale feature of the monsoon	Student will be able to understand monsoon inversion, on set of monsoon, withdrawl of monsoon, active and break monsoon	**Contents**	Monsoon inversion, on set of monsoon, withdrawl of monsoon, active and break monsoon,	
			Objectives	• To understand monsoon inversion • To understand on set of monsoon, withdrawal of monsoon, active and break monsoon,	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt,	
			Evaluation	• What are the feathers of active and withdrawal of monsoon? • What are the onset dates in south Asia?	
			Learning Achievement	• Understand the monsoon inversion, on set of monsoon, withdrawal of monsoon, • Understand active and break monsoon on south asia	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDMH)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
15th (120 min)	Precipation and mesoscale feature of the monsoon	Student will be able to understand floods and drought trends of monsoon	**Contents**	Floods and drought trends of monsoon	
			Objectives	• To understand how flood and drought connection with SOI and SST • Weak or strong connection between SOI and drought and flood	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the feathers of flood and drought in summer monsoon? • How drought and flood variability on the Globe?	
			Learning Achievement	• Understand floods and drought trends of monsoon • Understand flood and drought causes disasters	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

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TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDMH)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
16th (120 min)	Climatological march of the seasons	Student will be able to understand role of the Himalayan-Tibetan Massif in the monsoons during different seasons	**Contents**	Role of the Himalayan-Tibetan Massif in the monsoons during different seasons.	
			Objectives	• To understand features of monsoon(Variability) • To learn heat low and associated weather • To understand monsoon depression mechanism	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the feathers of summer monsoon? • What are the favorable conditions for heat low? • How SW monsoon are depressed?	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
			Learning Achievement	• Understand role of the Himalayan-Tibetan Massif in the monsoons during different seasons. • Understand Himalayan-Tibetan Massif and its importance in Asia	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Institute:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology (CDMH)
Level:	MSc	**Year/Semester:**	II
Subject:	Synoptic Meteorology	**Course No.:**	Hymet 551
Full Marks:	50	**Total Period:**	30 lecture hours

Detail Plan of Action for Course Facilitation

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
17th	General Circulation Features	Student will be able to understand	**Contents**	Winter seasons (winter monsoon), Summer seasons (pre-monsoon, monsoon, post monsoon).	

Class/ Period	Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Remarks
(120 min)	over Nepal during the seasons	Winter seasons (winter monsoon), Summer seasons(pre-monsoon, monsoon, post monsoon)	**Objectives**	• To understand the features of winter seasons rainfall Variability over Nepal • To understand monsoon fluctuation in pre, post and monsoon seasons in Nepal	
			Teaching Methods	Didactic questioning, Short lecturing, Peer teaching, Discussion, Audiovisual,	
			Materials	Whiteboard and marker, Multimedia projector, Laptop with ppt	
			Evaluation	• What are the feathers of summer monsoon? • Discuss the winter seasons rainfall variability in Nepal?	
			Learning Achievement	• Understand Winter seasons rainfall variability • Understand Summer seasons (pre-monsoon, monsoon, post monsoon) rainfall characteristics	
			Prescribed/ Basic Book	Pettersen,s. Weather analysis and forecasting. Vol 1and 2,Mc-2, Mc-Graw Hill Book Company Inc,New York 1956.	

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
neto- ronic cture	**Identify** **a) D-region** **b) E-region** **c) F-region**	**Contents**	Ionosphere
		Objectives	The students will be able to - (a) conceptualize the different layers of the upper atmosphere (b) differentiate the layers within the ionosphere (c) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Name the layers of the upper atmosphere? • How the behavior and numbers of free electrons and other charged particles differentiate the upper atmosphere? • What is ionosphere?
		Learning Achievement	• Understand the electromagnetic structure of the ionosphere • Distinguish between various region of the Ionosphere • Draw the Schematic diagram of ionosphere.
		Prescribed/ Basic Book	Atmospheric structure https://www.albany.edu/faculty/rgk/atm101/structur.htm

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
neto- ronic cture	Identify the structure and extension of the Plasmasphere	**Contents**	Plasmasphere
		Objectives	The students will be able to - a) conceptualize the constituents of the Plasmasphere b) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about Plasmasphere. • How the behavior and numbers of free electrons and other charged particles in Plasmasphere is different from Ionosphere
		Learning Achievement	• Understand the electromagnetic structure of the Plasmasphere • Draw the Schematic diagram of ionosphere.
		Prescribed/ Basic Book	Atmospheric structure https://www.albany.edu/faculty/rgk/atm101/structur.htm

Prepared By: Mr. Damodar Bagale

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
neto- ronic cture	Identify the structure and extension of the Magnetosphere	**Contents**	Magnetosphere
		Objectives	The students will be able to – a) conceptualize the constituents of the Magnetosphere b) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about Magnetosphere. • How the behavior and numbers of free electrons and other charged particles in Magnetosphere is different from Ionosphere and Plasmasphere
		Learning Achievement	• Understand the electromagnetic structure of the Magnetosphere • Draw the Schematic diagram of Magnetosphere.
		Prescribed/ Basic Book	Atmospheric structure https://www.albany.edu/faculty/rgk/atm101/structur.htm

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TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
e ry	Get information about the history of ozone layer from 1800's, till to future 2050's.	**Contents**	Historical background
		Objectives	The students will be able to – conceptualize the initiation of the Ozone layer and its studies by scientists at different periods (ozone spectrophotometer, chlorofluorocarbons , Sydney Chapman theory, Ozonesonde, supersonic transport)
		Teaching Methods	Questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Which scientist invented ozone spectrophotometer for what purpose? • What are chlorofluorocarbons? • What is supersonic transport?
		Learning Achievement	• Understand the history of ozone layer • List outs the Outline of the history of ozone layer
		Prescribed/ Basic Book	A Brief History of Ozone https://www.albany.edu/faculty/rgk/atm101/o3histor.htm https://svs.gsfc.nasa.gov/11644

TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	Description/Particulars
e ry	Visualize the concentration of the ozone from 1980 to 2070	**Contents**	Historical background
		Objectives	The students will be able to – About NOx catalytic cycle, Total Ozone Mapping Spectrometer, Vienna Convention, Montreal Protocol , Hydrochlorofluorocarbon
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• What is Montreal Protocol? How its adaptation enhances the atmospheric chemistry? • Write about the concentration of ozone layer
		Learning Achievement	• Understand the electromagnetic structure of the Magnetosphere • Draw the Schematic diagram of Magnetosphere.
		Prescribed/ Basic Book	A Brief History of Ozone https://www.albany.edu/faculty/rgk/atm101/o3histor.htm https://svs.gsfc.nasa.gov/11644

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
e ry	Identify the structure, occurrence and properties of the ozone layer	**Contents**	Formation of ozone layer
		Objectives	The students will be able to – c) conceptualize the formation of the ozone d) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about the formation of ozone layer? • How we can define the latest global distribution of ozone
		Learning Achievement	• Know about the variability of the ozone layer. • Understand the distribution of ozone
		Prescribed/ Basic Book	Atmospheric structure http://ozone.meteo.be/meteo/view/en/1547926-The+ozone+layer.html

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TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
e ry	Identify the sources of ozone layer	**Contents**	Sources of ozone layer.
		Objectives	The students will be able to – a) conceptualize the sources of the ozone layer b) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about sources of ozone layer. • How the ozone layer is affected by other constituents
		Learning Achievement	• Understand the sources of the ozone layer • Draw the Schematic diagram of ozone in the atmosphere
		Prescribed/ Basic Book	Atmospheric structure https://www.epa.gov/ozone-layer-protection/basic-ozone-layer-science

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology

Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
ct of raviolet-VB) ation	Identify the effect of **ultraviolet-B (UVB) radiation**	**Contents**	Effect on human health, plants, marine ecosystem, biogeochemical cycles, materials, atmospheric circulation.
		Objectives	The students will be able to – a) Conceptualize the effect of UVB on different materials and bio organisms.
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• What are the effects of Ultraviolet-B(UVB) Radiation?
		Learning Achievement	• Understand the the effects of Ultraviolet-B(UVB) Radiation. • Listing out the factors on which. Ultraviolet-B(UVB) Radiation effects.
		Prescribed/ Basic Book	Atmospheric structure https://www.fda.gov/radiation-emitting-products/tanning/ultraviolet-uv-radiation#4

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CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601

Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
ospheric e	Identify the vertical and latitudinal distribution of the ozone	**Contents**	Formation and destruction of ozone
		Objectives	The students will be able to – b) conceptualize the chemistry of the ozone layer c) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about the stratospheric ozone with diagram. • What is Chapman Mechanism?
		Learning Achievement	• Understand the nature of stratospheric ozone • Can write the equation of Chapman Mechanism.
		Prescribed/ Basic Book	Atmospheric Chemistry http://acmg.seas.harvard.edu/people/faculty/djj/book/bookchap10.html

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Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
ospheric e	Identify the chemical reactions of Chapman mechanism and figure out the steady-state solution	**Contents**	Formation and destruction of ozone
		Objectives	The students will be able to – d) conceptualize the constituents of the Magnetosphere e) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Discuss the chapman mechanism for ozone formation and destruction.
		Learning Achievement	• Understand the Chapman mechanism for formation and destruction of ozone layer.
		Prescribed/ Basic Book	Atmospheric Chemistry http://acmg.seas.harvard.edu/people/faculty/djj/book/bookchap10.html

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Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars	Re
Stratospheric ozone	Identify the catalytic loss cycle of Hydrogen oxide radicals (HOx)	**Contents**	Catalytic loss cycles	
		Objectives	The students will be able to – conceptualize the constituents of hydrogen oxide radicals for formation and destruction	
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice	
		Materials	White board and marker, Multimedia projector, Laptop with ppt,	
		Evaluation	A termination step for the HOx radical chain is $HO_2 + HO_2 \rightarrow H_2O_2$ (hydrogen peroxide) Hydrogen peroxide can go on to either photolyze or react with OH: $H_2O_2 + h\nu \rightarrow 2OH$ $H_2O_2 + OH \rightarrow H_2O + HO_2$ Whether H_2O_2 photolyzes or reacts with OH has a large effect on HOx-catalyzed ozone loss, explain why.	
		Learning Achievement	• Understand the catalytic ozone loss by hydrogen oxide radicals • Write the chemical reaction of the catalytic loss by HOx radical	
		Prescribed/ Basic Book	Atmospheric Chemistry http://acmg.seas.harvard.edu/people/faculty/djj/book/bookchap10.html	

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Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
ospheric e	Identify the catalytic loss cycle of Nitrogen oxide radicals (NOx)	**Contents**	Catalytic loss cycles
		Objectives	The students will be able to – conceptualize the constituents of Nitrogen oxide radicals (NOx) for formation and destruction
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	N_2O in the stratosphere can react by two alternate pathways: $N_2O + h\nu \rightarrow N_2 + O$ (1) and $N_2O + O(^1D) \rightarrow 2NO$ (2) Show that competition between (1) and (2) lends stability to the ozone layer, i.e., acts as a negative feedback to an ozone perturbation.
		Learning Achievement	• Understand the catalytic ozone loss by Nitrogen oxide radicals • Write the chemical reaction of the catalytic loss by NOx radical

apter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
		Prescribed/ Basic Book	Atmospheric structure https://www.albany.edu/faculty/rgk/atm101/structur.htm

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TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
ospheric e	Identify the catalytic loss cycle of Chlorine radicals (ClOx)	**Contents**	Catalytic loss cycles
		Objectives	The students will be able to – conceptualize the constituents of Chlorine radicals (ClOx) for formation and destruction
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Discuss the catalytic loss cycle of the Chlorine radicals. • Show the sources and sinks of stratospheric ClOx and Cly by figure.
		Learning Achievement	• Understand the catalytic ozone loss by Chlorine radicals (ClOx) • Write the chemical reaction of the catalytic loss by ClOx radical
		Prescribed/ Basic Book	Atmospheric structure https://www.albany.edu/faculty/rgk/atm101/structur.htm

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TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
ospheric e	Identify the mechanism for ozone loss	**Contents**	Polar ozone loss (mechanism)
		Objectives	The students will be able to – a)conceptualize the reactions involved in polar ozone loss
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write the mechanism of polar ozone loss • Write the reaction of polar ozone loss
		Learning Achievement	• Understand the mechanism of polar ozone loss • List out the reactions of the polar ozone loss.
		Prescribed/ Basic Book	Atmospheric chemistry (http://acmg.seas.harvard.edu/people/faculty/djj/book/)

……Earina Sthapit……

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TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
ospheric e	Identify the mechanism of PSC formation	**Contents**	polar ozone loss (PSC formation)
		Objectives	The students will be able to – conceptualize the constituents of PSC formation
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about PSC formation • Write the chemical name of NAT,NAD and NAM and its combination of in PSC formation
		Learning Achievement	• Understand the mechanism of the PSC formation • Draw the Schematic diagram of occurrence of PSC in SH and NH
		Prescribed/ Basic Book	Atmospheric chemistry (http://acmg.seas.harvard.edu/people/faculty/djj/book/)

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
ospheric e	Identify the structure chronology of the ozone hole	**Contents**	polar ozone loss (chronology of the ozone hole)
		Objectives	The students will be able to – a)conceptualize the chronology of the ozone hole f) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about the chronology of the ozone hole • Write the reaction involved in the chronology of the ozone hole
		Learning Achievement	• Understand the chronology of the ozone hole • Draw the Schematic diagram of chronology of the ozone hole
		Prescribed/ Basic Book	Atmospheric chemistry (http://acmg.seas.harvard.edu/people/faculty/djj/book/)

TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
he **ution**	Identify the air pollution in concentrated zone of ozone	**Contents**	**Air pollution and ozone**
		Objectives	The students will be able to – a) conceptualize the relation of air pollution and ozone b) visualize the concentration layer of ozone associate with pollution
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about ozone air pollution. • How the concentration of ozone vary the air pollution
		Learning Achievement	• Understand the relation between the concentration of ozone and air pollution.
		Prescribed/ Basic Book	Atmospheric Chemistry

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
ne ution	Identify the chain reaction mechanism of ozone formation and strategies	**Contents**	**ozone formation and control strategies**
		Objectives	The students will be able to – a) Conceptualize the reaction mechanism of formation and control strategies. b) visualize the trend of concentration of ozone
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write the cycling of HOx and O3 production in a polluted atmosphere. • How ozone concentration simulates by a function of NOx and hydrocarbon emissions?
		Learning Achievement	• Understand the mechanism of formation and control strategies
		Prescribed/ Basic Book	Atmospheric Chemistry

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
he tion	Identify the equation for the ozone production efficiency	**Contents**	**ozone production, efficiency**
		Objectives	The students will be able to – a) conceptualize the chemical reaction evolve in ozone production efficiency
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about ozone production efficiency
		Learning Achievement	• Understand about the ozone production efficiency • Draw the emission and deposition chart of ozone production efficiency
		Prescribed/ Basic Book	Atmospheric Chemistry

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY

TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
rain	Identify the chemical composition of precipitation	**Contents**	**Chemical composition of precipitation**
		Objectives	The students will be able to – b) conceptualize the constituents of the chemical composition of precipitation
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write the chemical composition of natural precipitation. • Write about SO42-,NO3-, and NH4+ in precipitation
		Learning Achievement	• Understand the chemical composition of precipitation
		Prescribed/ Basic Book	Atmospheric Chemistry

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
rain	Identify the effects and trend of acid rain	**Contents**	**sources of acids, effects of acid rain**
		Objectives	The students will be able to – a) conceptualize the sources of acids: sulfur chemistry
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about the sources and effects of acid rain
		Learning Achievement	• Understand the sources and effect of acid rain
		Prescribed/ Basic Book	http://acmg.seas.harvard.edu/people/faculty/djj/book/bookchap13.html

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology

Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
rain	**Identity emission of SO_2 and NO_x and its effect during acid rain**	**Contents**	**emission of SO_2 and NO_x.**
		Objectives	The students will be able to – • Conceptualize the effect of emission of SO_2 and NO_x during acid rain.
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• How the emission of SO_2 and NO_x during acid rain destruct the environment?
		Learning Achievement	• Understand the effect of emission of SO_2 and NO_x
		Prescribed/ Basic Book	https://hspcb.gov.in/content/ecoclub/Acid_Rain.pdf

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
nistry **spheric sol**	Identify the structure and extension of the Magnetosphere	**Contents**	Magnetosphere
		Objectives	The students will be able to – b) conceptualize the constituents of the Magnetosphere c) visualize the layer
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about Magnetosphere. • How the behavior and numbers of free electrons and other charged particles in Magnetosphere is different from Ionosphere and Plasmasphere
		Learning Achievement	• Understand the electromagnetic structure of the Magnetosphere • Draw the Schematic diagram of Magnetosphere.
		Prescribed/ Basic Book	Atmospheric structure https://www.albany.edu/faculty/rgk/atm101/structur.htm

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TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
nistry **ospheric sol**	Identify the structure and extension of the Magnetosphere	**Contents**	**Importance and sources of tropospheric and stratospheric aerosol, volcanic aerosol, desert dust, human made aerosol,**
		Objectives	The students will be able to – • Conceptualize the different types of aerosol and its importance.
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write the importance and sources of tropospheric and stratospheric aerosol • Write the different types of aerosol, explain in brief.
		Learning Achievement	• Understand the importance and different types of aerosol.
		Prescribed/ Basic Book	Atmospheric Chemistry

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY
TEACHING PLAN

Faculty:	Science	**Department:**	Central Dept. of Hydrology and Meteorology
Level:	Master (M.Sc.)	**Year/Semester:**	III semester
Subject:	Atmospheric Chemistry	**Course No.:**	Hymet 601
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
nistry **spheric sol**	Identify the structure and extension of the Magnetosphere	**Contents**	**Climatic effect of aerosol, the removal of aerosol, aerosol as atmospheric tracers, NASA's aerosol studies**
		Objectives	The students will be able to – a) conceptualize the properties of aerosol and its studies
		Teaching Methods	Didactic questioning, Short lecturing, Discussion, and Skills practice
		Materials	White board and marker, Multimedia projector, Laptop with ppt,
		Evaluation	• Write about climatic effect of aerosol. • How aerosol removed from atmosphere?
		Learning Achievement	• Understand the effects and importance of atmospheric aerosol.
		Prescribed/ Basic Book	Atmospheric Chemistry

Prepared By: Earina Sthapit

Tribhuvan University
Central Department of Hydrology and Meteorology, Kirtipur, Kathmandu, Nepal
TEACHING PLAN

Faculty:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology
Level:	Masters	**Year/Semester:**	**I**
Subject:	Fortran programming / Practical (Compulsory)	**Course No.:**	Hymet 507
Full Marks:		**Total Period:**	60 lecture hours (2 Hours per class, 2 class per week)

Detail Plan of Action for Course Facilitation

apter/ Unit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
e	1. Introduction to computer Language	**Contents**	Computer Languages, The History of the Fortran Language, The Evolution of Fortran
		Objectives	1. Get an ideal of what computer language is. 2. Background of FORTRAN
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation.
		Evaluation	1. What is computer language? 2. What is f77, f90, f95 ?
		Learning Achievement	Introduction to computer language.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

apter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
o	Basic Elements of Fortran	**Contents**	The Fortran Character Set, The Structure of a Fortran Program, Constants and Variables, Assignment Statements and Arithmetic Calculations, Intrinsic Functions, Initialization of Variables, The IMPLICIT NONE Statement, Program Examples
		Objectives	1. Introduction To FORTRAN 2. Know basic elements of FORTRAN Language
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation,
		Evaluation	1. What are characters used in FORTRAN. 2. What is Constant, variable? 3. Write An arithmetic expression in FORTRAN code. 4. What is intrinsic function? 5. Write a basic FORTRAN code
		Learning Achievement	Write basic FORTRN code.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

hapter Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
hree	1. Branch program using conditional arguments.	**Contents**	Introduction to Top-Down Design Techniques, Logical Constants, Variables, and Operators, The Block IF Construct, The ELSE and ELSE IF Clauses, The SELECT CASE Construct
		Objectives	1. Introduction To splitting program to section using arguments. 2. Use logic to solve problems
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation,

hapter Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
		Evaluation	1. What is a logical operator? 2. Compare a number if it is even or odd. 3. Write a code that uses ELSE IF Clauses.
		Learning Achievement	Handle real time logical questions in code.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

Chapter / Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
our	Writing Piece of Codes For repeat ion , Loops	**Contents**	The While Loop, The DO WHILE Loop, The CYCLE and EXIT Statements, Named Loops , Nesting Loops and Block IF Constructs
		Objectives	1. Write codes that is used to handle repeated section. 2. Learn different ways of writing the loop. 3. Pass the control of the program in different sections i loop.
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation,
		Evaluation	1. Write a code to display a series of numbers from 1 to 2. Write a code that uses Do loop. 3. How to terminate While loop? 4. Write a condition to exit from a loop.
		Learning Achievement	1. Know what loops are and when to use. 2. Learn how to write program with loop.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Editi McGraw-Hill Education,2018

Chapter / Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
Fifth	Pass input / output through the components of computer	**Contents**	Formats and Formatted WRITE Statements, Formatted READ Statements, An Introduction to Files and File Processing
		Objectives	1. Write codes that handle different display patterns of a Real numbers, integers and character. 2. Use different read and write techniques in Fortran. 3. Pass content in and out of program using files.
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation,
		Evaluation	1. What is a way to represent real number with one decimal place? 2. How to read a string of numbers? 3. What is the meaning of OPEN statement? 4. What is the meaning of CLOSE statement? 5. How to Pass a file input in READ and WRITE statement?
		Learning Achievement	1. Use technique to format the numbers and characters. 2. Handle files to give in input and give out output from a Program.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

Chapter / Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
Sixth	Using Array as a sequence of number.	**Contents**	Declaring Arrays, Using Array Elements in Fortran Statements, Input and Output of Array Elements, 2D or Rank 2 Arrays, Multidimensional or Rank n Arrays, Allocatable Arrays
		Objectives	1. Learn what is an array. 2. Write an array.

Chapter / Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
			3. Using an array of numbers. 4. Declare different dimension of array.
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation,
		Evaluation	1. What does the following lines designate integer, dimension(5) :: arr1 arr1 = (/1,2,3,4,5/) 2. What is 2D array? 3. What is an Allocatable array?
		Learning Achievement	1. Write a sequence of numbers. 2. Manipulate a set of number. (Write and Read) .
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

Prepared By: Netra Jit Kadka

Tribhuvan University
Central Department of Hydrology and Meteorology, Kirtipur, Kathmandu, Nepal
TEACHING PLAN

Faculty:	Institute of Science and Technology (IOST)	**Department:**	Central Department of Hydrology and Meteorology
Level:	Masters	**Year/Semester:**	**II**
Subject:	Fortran programming / Practical (Compulsory)	**Course No.:**	Hymet 557
Full Marks:		**Total Period:**	60 lecture hours (2 Hours per class, 2 class per week)

Detail Plan of Action for Course Facilitation

Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
One	Use Sub programs 1. Function 2. Subroutine **3.** Module	**Contents**	Subroutines, Module, Functions
		Objectives	1. How to code subprograms.
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation.
		Evaluation	1. Write a function to find cube root ? 2. What is a module, how to call it? 3. How to write a subroutine?
		Learning Achievement	Able to code function, subroutine, module.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
Two	Knowledge of derived types	**Contents**	Introduction to Derived Data Types, Declaring Derived Data Types in Modules, Dynamic Allocation of Derived Data Types
		Objectives	1. Use technique of Structure
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation.
		Evaluation	1. Declare a Derived type (structure)?
		Learning Achievement	Introduction to a basic element of OOP.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
Three	Project I 1. How to calculate ST.DEV 2. How to calculate Coeff of variation.	**Contents**	coefficient of variations using Daily precipitation data from all over Nepal
		Objectives	1. Work with Data 2. Write a code to for real case.
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation.
		Evaluation	1. Use the given code to calculate the coefficient of variations.
		Learning Achievement	Write some lines of code to do a real case study.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

Chapter/ Unit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
Three	Project II 1. How to calculate linear regression Write Code in Fortran as needed	**Contents**	linear trends for monthly, seasonal and annual distributions using Daily precipitation data from all over Nepal
		Objectives	1. Work with Data 2. Write a code for real case.
		Teaching Methods	lecturing, Discussion, solving errors for each students.
		Materials	White board and marker, Multimedia presentation.
		Evaluation	1. Use the given code to calculate the linear trends fo monthly, seasonal and annual case.
		Learning Achievement	Write some lines of code to do a real case study.
		Prescribed/ Basic Book	Stephen J. Chapman, Fortran for Scientists and Engineers, Fourth Edition, McGraw-Hill Education,2018

Prepared by: Netra Jit Khadka

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY,
KRITIPUR, KATHMANDU, NEPAL
TEACHING PLAN

Faculty:	Science	**Department: central Department of Hydrology and Meteorology**	
Level:	Master	**Year/Semester:**	I semester
Subject:	Hydrology	**Course No.:**	Hymet 505
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	Learning Outcomes of the Chapter/Unit	Major Components	Description/Particulars
er nce	• **Introduction of Hydrology** • **Briefing about syllabus** • **General components of Hydrology** • **Hydrological cycle**	**Contents**	Basic component of hydrology
		Objectives	The students will be able to - (a) Concepts about hydrological components (b) Knowledge about hydrological cycle
		Teaching Methods	Didactic questioning, Short lecturing
		Materials	Power point presentation through online
		Evaluation	• What is hydrology? • What are the major components of hydrology? • What did you understand by hydrological cycle? • What is the driving force for the hydrological cycle?
		Learning Achievement	• Introduction of Hydrology • General components of Hydrology • Hydrological cycle
		Prescribed/ Basic Book	K. Subramanya, Engineering Hydrology, New Delhi, India.

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY,
KRITIPUR, KATHMANDU, NEPAL
TEACHING PLAN

Faculty:	Science	**Department: central Department of Hydrology and Meteorology**	
Level:	Master	**Year/Semester:**	I semester
Subject:	Hydrology	**Course No.:**	Hymet 505
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
er nce	• **Detail study of Hydrological cycle** • **Factors affecting hydrological cycle** • **Rainfall estimation**	**Contents**	Basic component of hydrology
		Objectives	The students will be able to - (a) Factors affecting hydrology (b) Methods of Rainfall estimation
		Teaching Methods	Didactic questioning, Short lecturing
		Materials	Power point presentation through online
		Evaluation	• What is infiltration? • List out the factor which affects the hydrological cycle? • What did you understand by watershed? • What is isohyet?
		Learning Achievement	• Detail knowledge of hydrological components • Understanding of factors affects in hydrology • Different methods of rainfall estimation
		Prescribed/ Basic Book	K. Subramanya, Engineering Hydrology, New Delhi, India.

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY,
KRITIPUR, KATHMANDU, NEPAL
TEACHING PLAN

Faculty:	Science	**Department: central Department of Hydrology and Meteorology**	
Level:	Master	**Year/Semester:**	I semester
Subject:	Hydrology	**Course No.:**	Hymet 505
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
er nce	• **Introduction about water balance** • **Major components of water balance equation** • **Mechanism of precipitation** • **Different methods of estimation of evapotranspiration**	**Contents**	Water balance equation
		Objectives	The students will be able to - (c) Understand about water balance equation (d) Mechanism of precipitation
		Teaching Methods	Didactic questioning, Short lecturing
		Materials	Power point presentation through online
		Evaluation	• What is water balance? • List out the factor which affects the hydrological cycle? • What did you understand by watershed? • What is isohyet?
		Learning Achievement	• Detail knowledge of hydrological components • Understanding of factors affects in hydrology • Different methods of rainfall estimation
		Prescribed/ Basic Book	K. Subramanya, Engineering Hydrology, New Delhi, India.

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY AND METEOROLOGY,
KRITIPUR, KATHMANDU, NEPAL
TEACHING PLAN

Faculty:	Science	**Department: central Department of Hydrology and Meteorology**	
Level:	Master	**Year/Semester:**	I semester
Subject:	Hydrology	**Course No.:**	Hymet 505
Full Marks:	50	**Total Period:**	30

Detail Plan of Action for Course Facilitation

pter/ nit	**Learning Outcomes of the Chapter/Unit**	**Major Components**	**Description/Particulars**
er nce	• **Brief about Infiltration** • **Factors affecting infiltration** • **Measurements of infiltration** • **Infiltration indices**	**Contents**	Infiltration
		Objectives	The students will be able to - (a) Understand about infiltration (b) Understand different measurements of infiltration and infiltration indices
		Teaching Methods	Didactic questioning, Short lecturing
		Materials	Power point presentation through online
		Evaluation	• What is infiltration? • List out the factor which affects infiltrations? • What are the methods of measurements of infiltration? • What are infiltration indices?
		Learning Achievement	• Detail knowledge of infiltration • Understanding of factors affects infiltration • Detail knowledge about infiltration indices
		Prescribed/ Basic Book	K. Subramanya, Engineering Hydrology, New Delhi, India.

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Prepared By Anita TuiTui

Lesson Plan – 01

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Introduction**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	One

Objectives:

At the end of the topic, students will be able to:

- Conceptualize the Course credit and total marks coverage
- Visualize the course of contents
- Describe the importance and scope of Cloud physics

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Warmup the class with introducing each other's with sharing their aim and hobbies (10mins)
- Slide share and describe the overall course structures (10mins)
- Introduce the class about the course books and educational sites (5)
- Discussion on the importance and scope of cloud physics (10min)
- Address all the queries from students (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. What do you think about the formation of cloud?

Q2. How can you interpret the role of cloud to sustain Nepalese Agroeconomy.

Assignment: (2min)

- Describe the importance of clouds in earth surface water budget?

Text Books and References:

- Pruppacher H. R., and Klett, J.D., Microphysics of Clouds and Precipitation, Kluwler Academic Publishers, Netherland, 2000.
- Mason, B. J. The physics of clouds, Oxford University Press, 1971.
- Seinfeld John H. and Pandis Spyros N., Atmospheric Chemistry and Physics from air pollution to climate change, A Wiley-IntersciencePublication, 1997.
- Mason, B. J., Clouds and rain making, Cambridge University Press, 1962.
- WMO. (1969). International Cloud Atlas: Abridged Atlas. World Meteorological Organization.
- https://isccp.giss.nasa.gov/role.html

Lesson Plan – 02

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1st Sem.
Topic:	**Introduction**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	One

Objectives:

At the end of the topic, students will be able to:

- Identify and explain the major 10 types of cloud based on their altitude and appearance
- Explain what clouds are made of and their role in weather

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Describe on the identification and classification schemes of cloud (15mins)
- Discussion on cloud types based slide presentations and real time observation (15min)
- Suggest the solutions for student's queries related to the topic (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. Amongst the 10 types of cloud, how can you identify rain-making cloud?

Q2. Amongst the 10 types of cloud, which clouds can be classified under vertically developed cloud?

Q3. Which clouds are associated with fair weather?

Q4. Which cloud produce continuous rainfall and which one yield heavy shower with shorter duration.

Assignment:

- Write a short paragraph on cloud condensation nuclei (CCN)? Describe in brief about the formation of cloud?

Reference:

- Seinfeld John H. and Pandis Spyros N., Atmospheric Chemistry and Physics from air pollution to climate change
- Liou, K. N. (1992). Radiation and cloud processes in the atmosphere. Theory, observation, and modeling.
- WMO. (1969). International Cloud Atlas: Abridged Atlas. World Meteorological Organization.
- https://isccp.giss.nasa.gov/role.html

Lesson Plan – 03

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Introduction**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	One

Objectives:

At the end of the topic, students will be able to:

- Describe some important cloud species.
- Explain the importance of cloud in the atmosphere.
- Write different processes and mechanisms involved in cloud formation.

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Describe some important cloud species through tables and figures in slides(10)
- Explain in brief importance of cloud in the atmospheric processes and the associate Earth's surface climate.(10min)
- Discussion on the basic mechanisms that are involved in cloud formation (5mins)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Ask questions to some selected students and evaluate their response;

Q1. What are the different methods of cloud formation?

Q2. What are the possible controls of cloud formation?

Assignment: (2mins)

- Write an essay on importance of cloud formation in earth atmospheric system?

Reference:

- Seinfeld John H. and Pandis Spyros N., Atmospheric Chemistry and Physics from air pollution to climate change
- Liou, K. N. (1992). Radiation and cloud processes in the atmosphere. Theory, observation, and modeling.
- https://isccp.giss.nasa.gov/role.html

Lesson Plan – 04

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Fundamental concepts of thermodynamic**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Explain the importance of thermodynamics in cloud physics
- Describe the equation of state of dry air
- State and drive First law of thermodynamic.

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Describe the Equation of state of dry air (5)
- Step wise derivation First law of thermodynamic(20)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Drive the possible results for the following cases using first law of thermodynamics;
  (a) Isobaric process
  (b) Isothermal process
  (c) Isochoric process
- Cross check the results between students followed by teacher

Assignment: (2mins)

- What is potential temperature? Drive and expression $\boldsymbol{\theta = T\left(\frac{1000hPa}{p}\right)^{k}}$ using first law of thermodynamic under adiabatic process.

Reference:

- Atmospheric thermodynamics (Vol. 6). Springer Science & Business Media.
- Tsonis, A. A. (2002). An introduction to atmospheric thermodynamics. Cambridge University Press.

Lesson Plan – 05

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Fundamental concepts of thermodynamic**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Write the definition and concept of entropy.
- Drive Second law of thermodynamic.
- Conceptualize the importance of 2nd law of thermodynamics and entropy in the atmosphere

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Describe Entropy & Second law of thermodynamic with step wise derivation (15min)
- Discussion on the importance of Entropy & Second law of thermodynamic in the atmospheric study (10min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Based on the figure provided (Figure 1.) give the reasons for the following questions.
  (a) Which system provides high energy photons?
  (b) Which system is responsible for the high entropy created in the atmosphere? Why?

Assignment: (2mins)

- Write a paragraph on “the atmosphere can be considered as a giant thermodynamic engine”
- Write briefly on the Isobaric and Adiabatic processes.

Reference:

- Liu et al.(2011);Understanding Atmospheric Behaviour in Terms of Entropy: A Review of Applications of the Second Law of Thermodynamics to Meteorology Iribarne, J. V., & Godson, W. L. (Eds.). (2012).
- Atmospheric thermodynamics (Vol. 6). Springer Science & Business Media.

Lesson Plan – 06

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Fundamental concepts of thermodynamic**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Identify and explain thermodynamic variables like;
  (a) Extensive and intensive variables,
  (b) Vapor pressure & saturation vapor pressure.
- Describe the concept of Clauius-Clapeyron equation

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Discussion of different thermodynamics variables and concepts; (15min)
  (a)Atmospheric thermodynamic state, (b)Thermodynamic equilibrium, (c)Extensive and intensive variables, (d)Vapor pressure & Saturation vapor pressure, and others
- Discussion on Clauius-Clapeyron equation (10min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Distinguish whether the following variables are extensive or intensive in natures:
  (i) Pressure, density, Specific entropy
  (ii) Equation of state $p = \rho RT$
- What are open and closed systems? If there is no exchange of mass but immaterial exchange happens in the system, what type of system is it?
- Do you here about Intrinsic and extrinsic variables. What type of variable is terrestrial emission?

Assignment: (2mins)

- Write briefly on the Isobaric and Adiabatic processes.

Reference:

- Seinfeld John H. and Pandis Spyros N., Atmospheric Chemistry and Physics from air pollution to climate change
- Liou, K. N. (1992). Radiation and cloud processes in the atmosphere. Theory, observation, and modeling.

Lesson Plan – 07

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Thermodynamic processes involved in cloud and fog formation**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Explain the basic concept of cloud and fog formation.
- Conceptualize the Isobaric and Adiabatic cooling of moist air in the atmosphere.

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Discussion on the basic concepts on cloud and fog formation.(15mins)
- Theoretical description of Isobaric and Adiabatic processes involved in cooling of moist air in the atmosphere(10mins)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Can clouds be formed below the freezing level?
- Can you guess that either the isobaric or adiabatic processes can best describe the vertical development of cloud?

Assignment: (2mins)

- What do you mean by thermodynamic diagram? Describe any four the significant levels.

Reference:

- Seinfeld John H. and Pandis Spyros N., Atmospheric Chemistry and Physics from air pollution to climate change

Lesson Plan – 08

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Thermodynamic processes involved in cloud and fog formation**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Describe the physics of Isobaric and Adiabatic cooling of moist air in the atmosphere
- Drive an relation that, dew-point temperature (T_d) as a function of the prevailing (T_o) and relative humidity(RH) in isobaric cooling process.
- Compute the equations for cloud condensation level (h_{LCL}) and cloud condensation temperature (T_L)

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Describe Isobaric and Adiabatic processes involved in cooling of moist air with mathematical description. (15mins)
- Demonstrate the thermodynamic diagram to identify the significant levels (10min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Define (i) dew point temperature, (ii) Cloud condensation level
- What could be the dew point temperature at 850mb pressure if an air parcel has cooled isobarically at temperature of 5^{o}C to reach 50% RH?
- Finding the cloud condensation level (h_{LCL}) and cloud condensation temperature (T_L) for the given sounding data/plot (Figure 2.).

Assignment: (2mins)

- If the air parcel is lifted beyond the h_{LCL} what could be the expression for lapse rate Γ_s in terms of latent heat of condensation $(-H_s)$?

Reference:

- Seinfeld John H. and Pandis Spyros N., Atmospheric Chemistry and Physics from air pollution to climate change

Lesson Plan – 09

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1st Sem.
Topic:	**Thermodynamic processes involved in cloud and fog formation**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Describe the cooling with entrainment process in the atmosphere and cloud
- Explain some of the importance and effects of entrainment process
- Explain entrainment equation and cloud lapserate

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)

- Discussion on the general concept of entrainment process in the atmosphere and cloud in cooling of moist air.(10mins)
- Describe entrainment equation (5min)
- Teacher-student interaction on "the importance and effects of entrainment process" (10min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Define entrainment process
- Can you modify the cloud lapserate with the introduction of entrainment process

Assignment: (2mins)

- What do you mean by the detrainment process? Describe how the entrainment is related to the RH.

Reference:

- Rooy et.al.,(2012); Review Article Entrainment and detrainment in cumulus convection: an overview

Lesson Plan – 10

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Thermodynamic processes involved in cloud and fog formation**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Drive a mathematical relation of cloud formation

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Revise shortly the Adiabatic and Entrainment processes in cooling of the atmospheric moisture (5min)
- Describe the derivation processes and steps on 'simplified mathematical description of cloud formation'(20min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Define entrainment process
- Modify the cloud lapserate with the introduction of entrainment process

Assignment: (2mins)

- Does the entrainment process also alter in mixing ratio? If so, what could be the expression for the rate of change of water vapor mixing ratio within the air parcel, drive it.

Reference:

- https://journals.ametsoc.org/jas/article/47/8/1012/22753
- Rooy et.al.,(2012); Review Article Entrainment and detrainment in cumulus convection: an overview

Lesson Plan – 11

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Growth of cloud droplets**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Describe the important factors the determine the cloud droplet growth
- Write in detail about the growth of an individual cloud droplet by the diffusion of water vapor

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Describe different factors that determine the cloud droplet growth.(5mins)
- Describe in details about the growth of an individual cloud droplet by diffusional process with considering the vapor concentration and surface area method (20min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- How vaper concentration gradient and vapor pressure gradient exist in the atmosphere and what could be its impact in cooling process for creating favorable environment on cloud droplet growth.

Assignment: (2mins)

- Derive an expression for the growth rate of individual cloud droplet in term of mass or radius.

Reference:

- https://journals.ametsoc.org/jas/article/24/6/688/17343/Cloud-Droplet-Growth-by-Collection
- https://rmets.onlinelibrary.wiley.com/doi/abs/10.1002/qj.49708837603

Lesson Plan – 12

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Growth of cloud droplets**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

Describe the growth of an individual cloud droplet by Bergeron process and Collision and coalescence process

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Describe both the Bergeron process and Collision and coalescence process (10min)
- Teacher followed Student-Student interaction on the mechanism of "Bergeron process and Collision and coalescence process" (15min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (10mins)

- Which process is most appropriate for droplet growth in shallow layer cloud?

Assignment: (2mins)

- How do you define droplets population? Which thermodynamic process is most dominant in droplets growth?

Reference:

- Zhang, B., Zhu, M., Wang, C., & Guan, X. (2012). Analysis of Cloud Droplets Growth and Phase Transition Radiation Process. Energy Procedia, 16, 1003-1008.

Lesson Plan – 13

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Growth of cloud droplets**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Two

Objectives:

At the end of the topic, students will be able to:

- Explain and write the theory of growth of droplets population
- Describe Cloud condensation nuclei (CCN) mathematically

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(5mins)
- Describe the theory of growth of droplets population in term of production (P) and condensation (c)(20mins)
- Describe Cloud condensation nuclei (CCN) mathematically (10min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Define cloud condensation nuclei (CCN)
- What are the sources of aerosols in the context of your region?

Assignment: (2mins)

- Drive the solution for a $thermodynamic\ va$ Q_1.

Reference:

- https://theculturetrip.com/asia/nepal/articles/why-is-kathmandu-in-the-midst-of-a-pollution-crisis/#:~:text=A%20meeting%20held%20at%20the,projects%20(road%20expansion%20and%20a

- Saud, B., & Paudel, G. (2018). The threat of ambient air pollution in Kathmandu, Nepal. Journal of environmental and public health, 2018.

Lesson Plan – 14

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Hydrometeors**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Three

Objectives:

At the end of the topic, students will be able to:

- Define hydrometeors
- Describe hydrometeors (liquid or solid) that are suspended in air
- Differentiate fog, haze and mist.

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Introduction on hydrometeors (5min)
- Discussion on formation and characteristics of suspended hydrometeors(20min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Ask questions to some selected students and evaluate their response;

Q1.What difference could you expect between haze, mist and fog?

Q2.What could be the necessary condition for the formation of ice-fog and radiation fog?

Assignment: (2mins)

- Choose a location which usually have foggy morning and collect the temperature and relative humidity data for one year. Analyzed such parameters and compare for foggy and clear day.

Reference:

- Shrestha, S., Moore, G. A., & Peel, M. C. (2018). Trends in winter fog events in the Terai region of Nepal. Agricultural and Forest Meteorology, 259, 118-130.

Lesson Plan – 15

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Hydrometeors**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Three

Objectives:

At the end of the topic, students will be able to:

- Describe both solid and liquid types of precipitation
- Explain the necessary condition for freezing rain and formation of rime
- Distinguish the types of clouds in association with each hydrometeors

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Introduction on both solid and liquid form of hydrometeors that can reach the ground surface (15min)
- Description of hydrometeors that are associated cloud types (10min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Ask questions to some selected students and evaluate their response;

Q1. What are snow pellets and how can you distinguish them from hail?

Q2. What is diamond dust? How can you distinguish it in the atmosphere?

Assignment: (2mins)

- How the structure of snow crystal get formed? Describe the physical processes involved in such process.

Reference:

- https://www.noaa.gov/stories/how-do-snowflakes-form-science-behind-snow#:~:text=A%3A%20A%20snowflake%20begins%20to,That's%20the%20short%20answer.

Lesson Plan – 16

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Hydrometeors**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Three

Objectives:

At the end of the topic, students will be able to:

- Define severe storm and hail
- Conceptualize the life cycle of thunderstorm cells
- Visualize the basic thermodynamics of hail growth

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Introduction on severe storm and hail (5min)
- Description of the life cycle of thunderstorm cells (10min)
- Explanation on the basic thermodynamics of hail growth with thermodynamic diagram(10min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Ask questions to some selected students and evaluate their response;

Q1. What could be the CAPE value for hail event (with the help of thermodynamic plot)?

Q2. Find out the lapserate between 850–500 hPa and 500–300 hPa (in the given thermodynamic plot)??

Assignment: (2mins)

- Prepare the case study report on hail event (based on your choise).

Reference:

- Aryal, D. (2018). Severe Hail Storm at Thori: A Case Study. Tribhuvan University Journal, 32(1), 25-50.
- Dhungana, N., Silwal, N., Upadhaya, S., Regmi, S. K., & Adhikari, S. (2018). Local people's perception and awareness of climate change: a case study from community forests in Lamjung District, Western Nepal. Banko Janakari, 28(2), 60-71.

Lesson Plan – 17

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1st Sem.
Topic:	**Precipitation**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Four

Objectives:

At the end of the topic, students will be able to:

- Define precipitation
- Outline the necessary condition to release precipitation from any cloud
- Distinguish between the different types and forms of precipitation

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduce the necessary conditions of precipitation release from the cloud(10min)
- Discussion on different types and forms of precipitation (10min)
- Discussion on the precipitation measurement(5min)
- Address all the queries from students (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. What causes precipitation to fall as freezing rain?

Q2. What causes precipitation to fall as snow?

Assignment: (2min)

- Describe the role of precipitation to maintain water cycle?
- How can you predict for chance of rainfall with surface and upper air observation?

Reference:

- https://www.nationalgeographic.org/encyclopedia/water-cycle/#:~:text=When%20molecules%20of%20water%20vapor,rivers%2C%20streams%2C%20and%20lakes.
- https://www.accessscience.com/content/weather-forecasting-and-prediction/742600

Lesson Plan – 18

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Precipitation theories**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Four

Objectives:

At the end of the topic, students will be able to:

- Explain about the Collision - Coalescence theory
- Explain the Ice-crystal theory

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduction to the Collision-Coalescence theory and Ice-crystal theory for rain making (20min)
- Discussion on the importance of vapor pressure difference between water droplets and single ice crystal in making rain (5min)
- Address all the queries from students (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. Which theory you think is most appropriate for making snowfall? Why?

Assignment: (2min)

- How can you analyze rainfall anomalies if you have 30 years of observation?

Reference:

- https://www.researchgate.net/publication/311863614_Comparing_smallholder_farmers%27_perception_of_climate_change_with_meteorological_data_A_case_study_from_southwestern_Nigeria/figures?lo=1

Lesson Plan – 19

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Precipitation processes**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Four

Objectives:

At the end of the topic, students will be able to:

- Visualize the layer clouds
- Explain the physical processes responsible for the release of precipitation from layer clouds
- Sketch a schematic diagram of precipitation release process

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduction to the layer clouds (5min)
- Description of the physical processes involved in precipitation release from layer clouds with diagram(20min)
- Address all the queries from students (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. Is Wegener-Bergeron process is responsible for the release of precipitation from stratiform (layered) clouds? Why was it important?

Assignment: (2min)

- Find some differences between the layer and shower clouds?

Reference:

- https://link.springer.com/article/10.1007/BF02247277

Lesson Plan – 20

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Precipitation processes**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Four

Objectives:

At the end of the topic, students will be able to:

- Visualize the cumulus type or showers clouds
- Explain the physical processes responsible for the release of precipitation from showers clouds
- Sketch a schematic diagram of precipitation release process in shower cloud

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduction to the shower/cumulus clouds (5min)
- Description of the physical processes involved in precipitation release from shower clouds with diagram(20min)
- Address all the queries from students (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. Which cloud produce heavy precipitation for a short duration? How?

Assignment: (2min)

- Find some differences between the precipitation release process from layer and shower clouds?

Reference:

- https://link.springer.com/article/10.1007/BF02247277

Lesson Plan – 21

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Mesoscale structure of rain**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Four

Objectives:

At the end of the topic, students will be able to:

- Describe the observation technique of cloud to study the microphysical characteristics
- Visualize the organization of precipitation around a cold front
- Conceptualize the vertical profile of (a) Rechardson Number (b) potential temperature (c) wind shear and other parameters in the rain bearing clouds

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduction to the mesoscale features of the clouds (5min)
- Description of the precipitation around a cold front (10min)
- Demonstration of various meteorological parameters with their vertical profiles(10min)
- Address all the queries from students (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. What do you think about the existence of cold front mostly associated with rain shower? How?

Assignment: (2min)

- Describe briefly the distribution and structure of rainfall in a cyclone wave.

Reference:

- https://journals.ametsoc.org/mwr/article/123/2/241/65283

Lesson Plan – 22

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1st Sem.
Topic:	**Precipitation Efficiency of cloud**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Four

Objectives:

At the end of the topic, students will be able to:

- Conceptualize the clouds behaviors in the atmosphere
- Define and describe the precipitation efficiency of the clouds

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduction to the clouds behaviors in atmosphere (10min)
- Description of the precipitation efficiency of cloud based on drop-size distribution and other parameters (15min)
- Address all the queries from students (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. What causes the low precipitation efficiency of shower cloud?

Assignment: (2min)

- What do you think about the artificial modification of precipitation efficiency in cloud? Write your own views.

Reference:

- https://en.wikipedia.org/wiki/Weather_modification
- https://www.wmo.int/pages/prog/arep/wwrp/new/documents/WMR_documents.final_27_April_1.FINAL.pdf

Lesson Plan – 23

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Artificial weather modification**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Five

Objectives:

At the end of the topic, students will be able to:

- Introduce the historical scheme of cloud modification (global practices)
- Identify the historical lacking in weather modification practices

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduction on artificial weather modification (5mins)
- Introduction on various historical practices (global) on artificial weather modification (10mins)
- Interaction on major lacking on historical practices (10min)
- Suggest the solutions for student's queries related to the topic (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. What could be the economic benefits of artificial weather modification?

Q2. Is there any negative impact of artificial weather modification?

Assignment:

- Conduct a social survey in your community and make short report on historical practices of rainmaking in your community. Also highlight lacking in such practice.

Reference:

- https://www.npr.org/templates/story/story.php?storyId=16281915

Lesson Plan – 24

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Artificial weather modification**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Five

Objectives:

At the end of the topic, students will be able to:

- Highlight the importance of artificial weather modification
- Define cloud seeding
- Explain the effectiveness of cloud seeding and controlling factors

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Discussion on importance and challenges of artificial weather modification (10mins)
- Introduction on cloud seeding (10mins)
- Suggest the solutions for student's queries related to the topic (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. How the relative humidity (Moisture) and temperature within a cloud is important?

Assignment:

- Create an idea on "the artificial weather modification could enhance the recent climate change".

Reference:

- https://en.wikipedia.org/wiki/Weather_modification

- https://www.wmo.int/pages/prog/arep/wwrp/new/documents/WMR_documents.final_27_April_1.FINAL.pdf

Lesson Plan – 25

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Artificial weather modification**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Five

Objectives:

At the end of the topic, students will be able to:

- Explain different types of cloud seeding
- Conceptualize different seeding methods

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduction on types of cloud seeding (15mins)
- Introduction of different cloud seeding methods(10min)
- Suggest the solutions for student's queries related to the topic (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. What do you mean by Hygroscopic and Glaciogenic agents? Do you think about the feeding of direct water to the cloud become effective in rainmaking?

Assignment:

- Write a paragraph about your own ideas on "feasibility and effectiveness of aircraft seeding of cloud to enhance precipitation in Nepal".

Reference:

- https://indianexpress.com/article/explained/cloud-seeding-technology-delhi-pollution-iit-kanpur-study-6110548/
- https://india.mongabay.com/2019/08/what-is-cloud-seeding/
- https://en.wikipedia.org/wiki/Cloud_seeding

Lesson Plan – 26

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Artificial weather modification**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Five

Objectives:

At the end of the topic, students will be able to:

- Introduce both the warm and cold cloud
- Explain about the warm cloud seeding
- Create a diagram of warm cloud seeding

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Introduction on warm and cold cloud (5mins)
- Description on the warm cloud seeding (20min)
- Suggest the solutions for student's queries related to the topic (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. Create a schematic diagram of warm cloud seeding?

Assignment:

- Explain how china in 2008 Olympic practice to stop rain?

Reference:

- https://www.businessinsider.com/china-sets-aside-millions-to-control-the-rain-2016-7

- https://www.independent.co.uk/sport/olympics/how-beijing-used-rockets-to-keep-opening-ceremony-dry-890294.html

Lesson Plan – 27

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1st Sem.
Topic:	**Artificial weather modification**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Five

Objectives:

At the end of the topic, students will be able to:

- Explain about the cold cloud seeding
- Create a diagram of cold cloud seeding
- Conceptualize on artificial cloud and fog dissipation

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feedback to the assignment(10mins)
- Description on the cold cloud seeding (15min)
- Introduction on cloud and fog dissipation (10min)
- Suggest the solutions for student's queries related to the topic (10mins)

Evaluation: (8mins

- Ask questions to some selected students and evaluate their response;

Q1. Create a schematic diagram of cold cloud seeding?

Assignment:

- How many countries are involved in cloud seeding practice? Describe the physics of fog dissipation and hail suppression with examples.

Reference:

- https://en.wikipedia.org/wiki/Cloud_seeding
- https://climate.usu.edu/cloudSeeding/index.php
- https://india.mongabay.com/2019/08/what-is-cloud-seeding/

Lesson Plan – 28

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Microstructure of Clouds and Precipitation**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Six

Objectives:

At the end of the topic, students will be able to:

- Introduce the parameters that defines the microstructure of clouds
- Conceptualize on the different techniques to study the microstructure of clouds

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Introduction to the microstructure of cloud(15min)
- Description on the techniques used to study the microstructure of clouds (10min)
- Suggest the solutions for student's queries related to the topic (10mins)

Evaluation: (8mins)

- Ask questions to some selected students and evaluate their response;

Q1.How RADAR works on detecting droplets inside the clouds?

Assignment: (2mins)

- Describe the sensors that are equipped in aircraft for measurement of cloud microphysics.

Reference:

- https://climate.usu.edu/cloudSeeding/index.php

Lesson Plan – 29

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Microstructure of Clouds and Precipitation**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Six

Objectives:

At the end of the topic, students will be able to:

- Describe the relative humidity inside clouds and Fogs

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Introduction to the variation of relative humidity as temperature changes in vertical (10min)
- Explain the relative humidity inside clouds and Fogs with graph demonstration (15min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Ask questions to some selected students and evaluate their response;

Q1. What could be the range of RH inside the cloud and fog?

Assignment: (2mins)

- Review the following papers and make a review report

Reference:

- Willett et.al,.(2010); Willett, K. M., Jones, P. D., Thorne, P. W., & Gillett, N. P. (2010). A comparison of large scale changes in surface humidity over land in observations and CMIP3 general circulation models. Environmental Research Letters, 5(2), 025210.
- Alessandro.et al.,(2019): Cloud Phase and Relative Humidity Distributions over the Southern Ocean in Austral Summer Based on In Situ Observations and CAM5 Simulations. J. Climate, 32, 2781–2805, https://doi.org/10.1175/JCLI-D-18-0232.1.

Lesson Plan –30

Institute:	Institute of Science and Technology, TU	**Date:**	
Department:	Central Department of Hydrology and Meteorology	**Time:**	
Subject:	Cloud Physics (Hymet-504)	**Full Marks:**	50
Credit hrs:	2 (30 Lecture hrs.)	**Level:**	M.Sc.1stSem.
Topic:	**Microstructure of Clouds and Precipitation**	**Period:**	First
Instructor:	Ram Hari Acharya	**Unit:**	Six

Objectives:

At the end of the topic, students will be able to:

- Introduce about the microstructure of cloud and fog
- Explain the drop size distribution in clouds and Fogs

Resources:

- Computer with internet facility and presentation slides, White board and marker

Activities:

- Attendance (5mins)
- Feed back to the assignment(10mins)
- Introduction to the microstructure of cloud and fog (10min)
- Detail description of the drop size distribution in clouds and Fogs (15min)
- Discussion on student's queries related to the topic (10mins)

Evaluation: (8mins)

- Ask questions to some selected students and evaluate their response;

Q1.What could be the maximum and minimum drop size found to be distributed within a cloud?

Q1. What difference could you find in the droplets size as per the location?

Assignment: (2mins)

- Chose an event of foggy day in a surroundins surface station and analyze tha following parameters

(a) Relative humidity
(b) Temperature
(c) Wind speed

Reference:

- Gerber, H., 1991: Supersaturation and Droplet Spectral Evolution in Fog. J. Atmos. Sci., 48, 2569–2588, https://doi.org/10.1175/1520-0469(1991)048<2569:SADSEI>2.0.CO;2.