FYUG SYLLABUS
(3RD AND 4TH SEMESTER)

ECOLOGY AND ENVIRONMENTAL SCIENCE

ASSAM UNIVERSITY, SILCHAR

2024

COURSE OUTLINE

emester	Course category, marks and credit	Course title	Unit names
III	**Discipline Specific Core (DSC-201)** **Total Marks= 100** **Total Credits=4**	**ATMOSPHERE AND GLOBAL CLIMATE CHANGE**	Unit 1: Global energy balance Unit 2: Atmospheric circulation Unit 3: Global warming and climate change Unit 4: Ozone layer depletion Unit 5: Climate change and policy
	Discipline Specific Core (DSC-202) **Total Marks= 100** **Total Credits=4**	**WATER AND WATER RESOURCES**	Unit 1: Physico-chemical parameters of water Unit 2: Surface and subsurface water Unit 3: Water resources in India Unit 4: Marine resource management Unit 5: Water resources conflicts and policies
	Discipline Specific Minor (DSM-201) **Total Marks= 100** **Total Credits=4**	**ATMOSPHERE AND CLIMATE CHANGE**	Unit 1: Energy balance Unit 2: Atmospheric circulation Unit 3: Global warming and climate change Unit 4: Ozone layer Unit 5: Climate change policies

	Interdisciplinary Course (IDC-201) **Total Marks= 100** **Total Credits=3**	**ENVIRONMENTAL POLLUTION AND MANAGEMENT**	Unit1: Concept and types Unit2: Air pollution Unit 3: Water pollution Unit 4: Soil pollution Unit 5: Noise, radioactive and E- pollution
	Skill Enhancement Courses (SEC-201) **Total Marks= 100** **Total Credits=3**	**REMOTE SENSING AND GIS** **Total Marks= 100** **Total Credits=3**	Unit I: Introduction to RS and GIS Unit II: Physics of remote sensing and image resolutions Unit III: Image interpretation techniques Unit IV: Data types and data analysis in GIS Unit V: Application of RS and GIS in natural resource management
IV	**Discipline Specific Core (DSC-251)** **Total Marks= 100** **Total Credits=4**	**LAND AND SOIL DEGRADATION AND MANAGEMENT**	Unit 1: Fundamentals of soil science Unit 2: Soil degradation Unit 3: Landuse changes and land degradation Unit 4: Evaluation of land degradation Unit 5: Land and soil conservation
	Discipline Specific Core (DSC-252) **Total Marks= 100**	**SYSTEMATICS AND BIOGEOGRAPHY**	Unit 1: Concept and approaches to systematics Unit 2: Numerical and

	Total Credits=4		molecular systematics Unit 3: Introduction to biogeography Unit 4: Speciation and extinction Unit 5: Biogeography and its application
	Discipline Specific Core (DSC-253) **Total Marks= 100** **Total Credits=4**	**AIR, WATER, SOIL & SYSTEMATICS (PRACTICAL)**	
	Discipline Specific Minor (DSM-251) **Total Marks= 100** **Total Credits=3**	**ECOLOGY, ATMOSHERE AND CLIMATE CHANGE (PRACTICAL)**	
	Discipline Specific Minor (DSM-252) **Total Marks= 100** **Total Credits=3**	**CONCEPT OF ATMOSPHERE AND CLIMATE CHANGE**	Unit 1: Introduction and concepts Unit 2: Circulation of Atmosphere Unit 3: Global warming and climate change Unit 4: Ozone layer Unit 5: Climate change and policies

SEMESTER III

Discipline Specific Core (DSC-201)
ATMOSPHERE AND GLOBAL CLIMATE CHANGE
Total Marks= 100
Total Credits=4

Unit 1: Global energy balance

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere,Methods of transfer of heat energy on earth: conduction, convection and radiation; earth atmosphere energy balance, Milankovitch cycles.

Unit 2: **Atmospheric circulation**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; El Nino and La Nina; tropical cyclone; Indian monsoon and its development; Meteorology and atmospheric stability;meteorological parameters (temperature, air pressure, light intensity, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion.

Unit 3: Global warming and climate change

Trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs) causing the climate change; atmospheric windows; impact of global warming; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses.

Unit 4: Ozone layer depletion

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures.

Unit 5: Climate change and policy

Environmental policy debate; International agreements; Montreal protocol 1987;Kyoto protocol 1997;Paris Agreement (2015), Clean Power Plan (2015), India's Climate Change Policy; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Readings:

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.

6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2ndedition). Sage Publications.
10. Ross, M.T., & Murray. B.C. 2016. What is the fuel of the future ? Prospects under the Clean Power Plan. Energy Economics, 60, 451-459.
11. Savaresi, A. 2016. The Paris Agreement: A new beginning ? Journal of Energy & Natural Resources Law, 34(1), 16-26.

Discipline Specific Core (DSC-202)
WATER AND WATER RESOURCES
Total Marks= 100
Total Credits=4

Unit 1: Physico-chemical parameters of water

Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapo-transpiration; classification of water resources (oceans, rivers, lakes and wetlands); properties of water- Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity.

Unit 2: Surface and subsurface water

Introduction to surface and ground water; surface and ground water pollution; water table; vertical distribution of water; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; importance of watershed and watershed management; rain water harvesting in urban settings; rain water harvesting in rural settings.

Unit 3: Water resources in India

Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; Definition of a wetland; types of wetlands (fresh water and marine); ecological significance of wetlands; threats to wetlands, Ramsar Convention, 1971; major wetlands and wetland resources of N E India.

Unit 4: Marine resource management

Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approaches, construction techniques and monitoring of coastal zones); definition and concept ofexclusive economic zones (EEZs), criteria for determining the extent of EEZs, common challenges faced by coastal states in managing their EEZs.

Unit 5: Water resources conflicts and policies

Water resources and sharing problems, multi-purpose river valley projects in India and their environmental and social impacts; case studies of dams- Narmada and Tehri dam – social and ecological losses versus economic benefits; International conflicts on water sharing between India and her neighbours; National water policy; National River linking plan.

Readings

1. Bansil, P.C. 2004. Water Management in India. Concept Publishing Company, India.
2. Brebbia, C.A. 2013. Water Resources Management VII. WIT Press.
3. CEA. 2011. Water Resources and Power Maps of India. Central Board of Irrigation & Power.
4. Grumbine, R.E. & Pandit, M.K. 2013. Threats from India's Himalaya dams. Science 339: 36-37.
5. Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. Water Resource Systems Planning and Analysis. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications.

7. Schward& Zhang, 2003. Fundamentals of Groundwater. John Willey and Sons.
8. Souvorov, A.V. 1999. Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management. Elsevier Publications.
9. Vickers, A. 2001. Handbook of Water Use and Conservation. WaterPlow Press.

Discipline Specific Minor (DSM-201)
ATMOSPHERE AND CLIMATE CHANGE
Total Marks= 100
Total Credits=4

Unit 1: Introduction and concepts

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere, transfer of heat energy, Milankovitch cycles.

Unit 2: **Atmospheric circulation**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; El Nino and La Nina; meteorological parameters (temperature, air pressure, light intensity, relative humidity, wind speed and direction, precipitation); atmospheric stability.

Unit 3: Global warming and climate change

Trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs) causing the climate change; impact of global warming; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses.

Unit 4: Ozone layer

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures.

Unit 5: Climate change policies

Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997;Paris Agreement (2015), Clean Power Plan (2015), India's Climate Change Policy; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Suggested Readings:

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2ndedition). Sage Publications.

10. Ross, M.T., & Murray. B.C. 2016. What is the fuel of the future ? Prospects under the Clean Power Plan. Energy Economics, 60, 451-459.

11. Savaresi, A. 2016. The Paris Agreement: A new beginning ? Journal of Energy & Natural Resources Law, 34(1), 16-26.

Interdisciplinary course (IDC-201)
ENVIRONMENTAL POLLUTION AND MANAGEMENT
No. of Credits: 3
Total Marks=100
Theory

Unit 1: Concept and Types

Definition of pollution; pollutants; sources- point source, non- point source; classification of pollutants- Natural and Anthropogenic; biodegradable and non- biodegradable; Environmental pollution- sources, causes, types; effects of pollution on environment and human health.

Unit 2: Air pollution

Ambient air quality: air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on environment and human health (NOx, SOx, PM, CO, CO2, hydrocarbons and VOCs) and control measures; indoor air pollution.

Unit 3: Water pollution

Sources of surface and ground water pollution; water quality parameters and standards; eutrophication; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases.

Unit 4: Soil pollution

Concepts of soil pollution and degradation; Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies, Soil erosion

Unit 5: Noise pollution, Radioactive and E-pollution

Noise pollution – sources; permissible ambient noise levels; impacts; Radioactive materials and sources of radioactive pollution; effects of radiation; E- Pollution- sources; effects on environment and human health.

Suggested Readings:

1. Gurjar,B.R.,Molina,L.T.&OjhaC.S.P.2010.AirPollution:HealthandEnvironmentalImpacts. CRC Press,Taylor&Francis.
2. Hester,R.E.&Harrison,R.M.1998.AirPollutionandHealth.TheRoyalSocietyofChemistry, UK.
3. Park,K.2015.Park'sTextbookofPreventiveandSocialMedicine(23rdedition).Banarsi dasBhanotPublishers.
4. Pepper,I.L.,Gerba,C.P.&Brusseau,M.L.2006.EnvironmentalandPollutionScience.Elsevier AcademicPress.
5. Purohit,S.S.&Ranjan,R.2007.Ecology,Environment&Pollution.AgrobiosPublications.
6. Vesilind,P.J.,Peirce,J.J.,&WeinerR.F.1990.EnvironmentalPollutionandControl.Butterworth-Heinemann,USA.

Skill Enhancement Courses (SEC-201)
REMOTE SENSING AND GIS
Total Marks= 100
Total Credits=3

Unit 1: Introduction to RS and GIS

History and evolution of RS & GIS, types of RS, platforms and sensors, satellite mission in India, concept of GIS, components of GIS, integration of RS & GIS

Unit 2: Physics of remote sensing and image resolutions

Electromagnetic spectrum and its components, interaction of electromagnetic radiations with atmosphere, principle of transmission, absorption, reflection and emission, spectral signatures, concept and types of image resolutions

Unit 3: Image interpretation techniques

Visual interpretation techniques, elements of visual interpretation, digital interpretation techniques, supervised classification, unsupervised classification, introduction to advanced classification techniques of satellite imageries

Unit 4: Data types and data analysis in GIS

Projection systems, georeferencing, types of data, overlaying of data, querying of data, concept of digital elevation model

Unit 5: Application of RS and GIS

RS and GIS in forestry, water related studies, atmospheric studies, climate change monitoring, geological and geomorphological studies and urban studies

Readings:

Joseph G., and Jeganathan C. (2018).*Fundamentals of Remote Sensing* (3rdedn.). University Press.
Lillesand T. M.; Kiefer R. W. and Chipman J.W. (2015) *Remote Sensing and Image Interpretation.* (7th edn.)Wiley India.
Bhatta Basudeb (2021). Remote Sensing and GIS, (2nd edn.) Oxford University Press India
Newton, A.C. (2007).*Forest Ecology and Conservation: A Handbook of Techniques*. Oxford University Press.
Galati Stephen R. (2006). Geographic Information Systems Demystified. Artech House, Boston.
Canada Centre for remote sensing tutorial (2019) Fundamentals of Remote Sensing (available online)

Practicals on Remote Sensing and GIS

1. Browsing and downloading Satellite Imageries.
2. Ground truthing techniques.
3. Functioning of handheld navigation system.
4. Intrepretation of toposheets.
5. Finding geographic coordinates on toposheets.

Readings:

1. Sahoo, R.N., Sehgal, V.K., Pradhan, S., Gupta, V.K. and Kamble, K.H. 2012, Practical Manual on Basics of Remote Sensing Data Processing, GPS and GIS, Division of Agricultural Physics, Indian Agricultural Research Institute, New Delhi – 110 012, India, pp 100.

2. Lavender, S., & Lavender, A. (2023). Practical handbook of remote sensing. CRC Press.

3. Boro, A. (2021). *Handbook of Practicals in Remote Sensing GIS and GPS for Beginners*. Paperback edition.

4. Díaz-Delgado, R., Lucas, R., & Hurford, C. (2017). The Roles of Remote Sensing in Nature Conservation. A pratical guide and case studies, 1st ed, Cham, Switzerland: Springer, 1-318.

SEMESTER IV

CORE COURSE (DSC- 251)
LAND AND SOIL DEGRADATION AND MANAGEMENT
Total Marks= 100
No. of Credits: 4
Theory

Unit 1: Fundamentals of soil science

Land as a resource, soil health; soil formation; classification of soil; physical properties of soil; soil texture; soil water holding capacity; soil organic matter; soil micronutrients (nitrogen, sulphur, potassium and phosphorus)

Unit 2: Soil degradation

Types and causes of soil degradation; types of soil erosion; nutrient depletion; impact of soil loss and soil degradation on agriculture and food security; soil pollution due to mining and mineral extraction, industrial and urban development, toxic contaminants in soils(organic and inorganic).

Unit 3: Landuse changes and land degradation

Biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors;

Unit 4: Evaluation of land degradation

Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on farming communities; effects on food security; effects on nutrient cycles.

Unit 5: Land and soil conservation

Sustainable land use planning; need for soil conservation and restoration of soil fertility; role of databases and data analysis in landuse planning control and management; land tenure and land policy; participatory land degradation assessment; integrating land degradation assessment into conservation.

Suggested Readings:

1. Brady,N.C.&Well,R.R.2007.TheNatureandPropertiesofSoils(13Thedition),PearsonEducationInc.
2. Gadgil,M.1993.BiodiversityandIndia'sdegradedlands.Ambio22:167-172.
3. Johnson, D.L. 2006. Land Degradation (2nd edition). Rowman and Littlefield publishers
4. Marsh,W.M.&Dozier,J.1983.LandscapePlanning:EnvironmentalApplications.JohnWileyand Sons.

5. Oldeman,L.R.1994.Theglobalextentofsoildegradation.Soilresilienceandsustainablelanduse,9.(http://library.wur.nl/isric/fulltext/isricu_i26803_001.pdf).
6. Pandit,M.K.et.al.2007.Unreportedyetmassivedeforestationdrivinglossofendemicbiodiversityin Indian Himalaya.BiodiversityConservation16:153-163.
7. Pandit,M.K.&Kumar,V.2013.LanduseandconservationchallengesinHimalaya:Past,presentandfuture.In:Sodhi,N.S.,Gibson,L.&Raven,P.H.ConservationBiology:Voicesfrom theTropics.pp.123-133.Wiley-Blackwell,Oxford,UK
8. Peterson,G.D.,Cumming,G.S.&Carpenter,S.R.2003.Scenarioplanning:atoolforconservationinan uncertainworld.ConservationBiology17:358-366.

9. Scherr,S.J.1999.Soildegradation:A threattodeveloping-countryfoodsecurityby2020 (Vol. 27).InternationalFoodPolicyResearchInstitute.

Discipline Specific Core (DSC-252)
SYSTEMATICS AND BIOGEOGRAPHY
Credits= 4
TOTAL MARKS: 100

UNIT:1 CONCEPT AND APPROACHES TO SYSTEMATICS

Definition of systematics; taxonomic identification; keys; field inventory; herbarium; museum; botanical gardens; taxonomic literature; nomenclature; evidence from anatomy, palynology, ultrastructure, cytology, phyto-chemistry,; taxonomy databases.

UNIT:2 NUMERICAL AND MOLECULAR SYSTEMATICS

Characters; variations; Operational Taxonomic Units; character weighting and coding; phenograms; cladograms; DNA barcoding; phylogenetic tree (rooted, unrooted, ultrametric trees); clades: monophyly, paraphyly, polyphyly, homology and analogy; parallelism and convergence.

UNIT:3 INTRODUCTION TO BIOGEOGRAPHY

Genes as unit of evolutionary change; mutation; genetic drift; gene flow; natural selection; geographic and ecological variation; Concepts of biogeography; biogeographical rules- Gloger's rule, Bergmann's rule, Allen's rule, Geist rule.

UNIT:4 SPECIATION AND EXTINCTION

Types and processes of speciation- allopatric, parapatric, sympatric; ecological diversification; adaptive radiation, convergent and parallel evolution; dispersal and immigration; means of dispersal and barriers to dispersal; extinction.

UNIT:5 BIOGEOGRAPHY AND ITS APPLICATION

Biogeographical zones of India; Biogeography of North-East India; Application of biogeographical rules in design of protected area and biosphere reserves; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species.

Suggested Readings:

1. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. & Brown, J.H. 2010. Biogeography (4th edition). Sinauer Associates, Sunderland
2. Mani, M.S. 1974. Ecology and Biogeography in India. Dr. W Junk Publishers., The Hague.
3. Singh, G. 2012. Plant Systematics: Theory and Practice (3rd edition). Oxford & IBH Pvt. Ltd., New Delhi.
4. Wheeler, Q.D. & Meier R. 2000. Species Concepts and Phylogenetic Theory: A Debate. Columbia University Press, New York.
5. Williams, D. M., Ebach, M.C. 2008. Foundations of Systematics and Biogeography. Springer.
6. Wilkins , J. S. 2009. Species: A History of the Idea (Vol. 1). University of California Press.
7. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity- Principles and Practices . Oxford and IBH publications Co. Pvt. Ltd. New Delhi.

8. Gaston, K. J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK.

PRACTICAL
Discipline Specific Core (DSC-253)
AIR, WATER, SOIL & SYSTEMATICS
Total Marks- 100
Total Credits-4

SECTION- A

1. Comparative analysis of maximum-minimum temperature of past 30 years using data obtained from a meteorological station.
2. Study of heat-island effect.
3. Filed visit to nearby meteorological station.

SECTION- B

1. To determine pH of water of different water bodies (Pond, River, Lakes & Ground water)
2. To determine the transparency of water of Pond ecosystem by Secchi disc.
3. Study of simple ecosystems-pond, river etc. and submit a report.
4. Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
5. Visit to a wetland ecosystem and submit a report

SECTION- C

1. To determine the colour of soil samples by Munsell-soil colour chart.
2. To determine the pH of soil sampler by pH meter.
3. To determine the texture of soil sampler by sieving method.
4. To determine the moisture content of soil sampler by oven drying method.
5. To study the profile of a soil in the field.

SECTION-D

1. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label.
2. To prepare a checklist of birds in and around college campus.
3. Visit to a centre of Botanical Survey of India.

PRACTICAL
Discipline Specific Minor (DSM-251)
ECOLOGY, ATMOSHERE AND CLIMATE CHANGE
Total Marks- 100
Total Credits-3

SECTION- A

1. To study the allelopathic influence of one plant species.

2. To prepare a checklist of invasive species.

3. To study the plankton communities in a fresh water ecosystem.

4. To study the distribution of road side species and investigate the changes in species richness.

5. Field report: Visit to a forest/ river/ wetland ecosystem.

SECTION- B

1. Comparative analysis of maximum-minimum temperature of past 30 years using data obtained from a meteorological station.

2. Study of heat-island effect.

3. Filed visit to nearby meteorological station.

Discipline Specific Minor (DSM-252)
CONCEPT OF ATMOSPHERE AND CLIMATE CHANGE
Total Marks= 100
Total Credits=3

Unit 1: Introduction and concepts

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere, transfer of heat energy, Milankovitch cycles.

Unit 2: **Circulation of Atmosphere**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; El Nino and La Nina; meteorological parameters (temperature, air pressure, light intensity, relative humidity, wind speed and direction, precipitation); atmospheric stability.

Unit 3: Global warming and climate change

Trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs) causing the climate change; atmospheric windows; impact of global warming; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses.

Unit 4: Ozone layer

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures.

Unit 5: Climate change and policies

Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997;Paris Agreement (2015), Clean Power Plan (2015),India's Climate Change Policy; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Suggested Readings:

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.

8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2ndedition). Sage Publications.
10. Ross, M.T., & Murray. B.C. 2016. What is the fuel of the future ? Prospects under the Clean Power Plan. Energy Economics, 60, 451-459.
11. Savaresi, A. 2016. The Paris Agreement: A new beginning ? Journal of Energy & Natural Resources Law, 34(1), 16-26.