



जम्मू केंद्रीय विश्वविद्यालय

Central University of Jammu

राया-सूचानी, बागला, जिला सांबा-181143 जम्मू, जम्मू एवं कश्मीर
Rahya- Suchani (Bagla), District Samba - 181143, Jammu (J&K)

No. 4-1/EVS/CUJ/Reg/2020/53

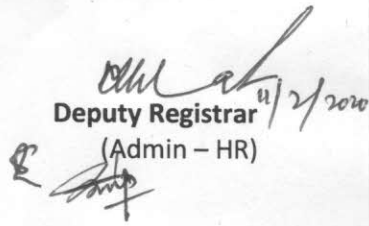
11 February, 2020

NOTIFICATION No. 11 / 2020

Sub: Course Matrix and Syllabus Notification of **Ph.D. in Environmental Sciences** w.e.f. Academic Session 2019-20 – Reg.

It is hereby notified for the information of all concerned that on the recommendation of the Board of Studies, Department of Environmental Sciences and School Board, School of Life Sciences, the Academic Council has approved following **Course Scheme** and **Syllabus** of Ph.D. in Environmental Sciences w.e.f. Academic Session **2019-20**.

Course Code	Course Title	Credit	ESE	Max. Marks
Compulsory Course				
PHEVS1C001T	Research Methodology	4	100	100
PHEVS1C002T	Advanced tools and techniques in Environmental Sciences	4	100	100
PHEVS1C003T	Current Environmental Issues and Challenges	4	100	100
Specialized Courses (Any One)				
PHEVS1E001T	Advanced Atmospheric Chemistry	4	100	100
PHEVS1E002T	Advances in Microbiology & Bioprocesses			
PHEVS1E003T	Advances in Geochemistry			
PHEVS1E004T	Atmospheric Processes & Climate Change			
PHEVS1E005T	Bioenergy and Nanomaterials			
Total		16	-	400


Deputy Registrar
(Admin - HR)

Encl: Syllabus of Ph.D.

To: Head, Department of Environmental Sciences

Copy to: OSD (Exam)

CENTRAL UNIVERSITY OF JAMMU
Syllabus for PhD in Environmental Sciences

Semester-I

Academic Year 2019-20

Subject course Code: PHEVS1C001T

Subject Course Title: Research Methodology

Duration of examination: 3 Hours

Credits:4

Maximum Marks: 100

Contact Hours/Week: 4

UNIT-I

Meaning, objectives, types and significance of Research; Research approaches, Research methods; Overview of Moral and Ethical questions in Scientific writing; Introduction to Intellectual Property Rights (IPR); Defining uncertainty of measurements, validation of method, calibration of method; QA/QC parameters in environmental sciences, use of CRMs, Inter-laboratory comparison exercise, participation in National and International round Robin tests; Citation analysis.

UNIT-II

Probability distribution and their properties, Normal, Poisson and Binomial distribution, sampling and test of significance, parametric and non-parametric test, correlation and regression, Error analysis.

UNIT-III

Introduction to philosophy: definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgements and reactions.

UNIT-IV

Ethics with respect to science and research; Intellectual honesty and research integrity; Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP); Redundant publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data.

UNIT-V

Publication ethics: definition, introduction and importance; Best practices/ standards setting initiatives and guidelines: COPE, WAME etc.; Conflicts of interest; Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types; Violation of publication ethics, authorship and contributorship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals.

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Suggested Readings

1. Principles of biometry by Charles M. Wolf
2. An Introduction to Geographical Information Systems, by Ian Heywood
3. Text book of quantitative chemical analysis by Vogel, I & Mendham, J. Vogel's
4. Practical Handbook of spectroscopy by James W. Robinson
5. Introduction to computers by P.K.Sinha
6. Quantifying Uncertainty in Analytical Measurement by Ellison and William
7. The Fitness for purpose of Analytical methods by Eurachem Guid

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CENTRAL UNIVERSITY OF JAMMU
Syllabus for PhD in Environmental Sciences

Semester-I

Academic Year 2019-20

Subject course Code: PHEVS1C00.3.T

Subject Course Title: Current Environmental Issues and Challenges

Duration of examination: 3 Hours

Credits:4

Maximum Marks: 100

Contact Hours/Week: 4

UNIT I

Global Environmental Issues: Biodiversity loss, Climate change, Ozone layer depletion, Sea level rise, International efforts for environmental protection, Carbon sequestration and carbon credits.

UNIT II

National Action Plan on Climate Change: Eight National missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a 'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change; Waste Management – Swachha Bharat Abhiyan; Green Building, GRIHA Rating Norms.

UNIT III

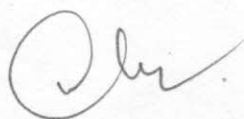
Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

UNIT IV

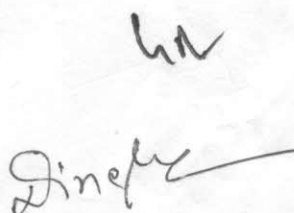
Environmental Disasters: Minamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukushima Daiichi nuclear disaster, 2011; Australian Bush fire (2019)

UNIT V

Environmental policies and Laws (Indian): National Environment Policy, 2006; National Action Plan on Climate Change, 2008; National Green Tribunal Act, 2010; Environment Protection Act, 1986; The Water (Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008; Vehicular emission norms in India.









Suggested Readings:

1. Sharma, P. D., and P. D. Sharma. Ecology and environment. Rastogi Publications, 2012.
2. De, A. K. "Environmental chemistry 7th edn." New Age International Publications, New Delhi (2010)
3. Garg, V.K., Bishnoi, M.S., and Malik, C.P. Environmental Policies and Laws. Kalyani Publishers, 2002
4. Leelakrishnan, P. Environmental law in India. LexisNexis, 2016.
5. Sharma, B. K., and H. Kaur. "Environmental Chemistry, Meerut." India, Krishna Prakashan (1994).
6. Singh, S., Allen, T., Tyagi, R.K. Basic Environmental Sciences for Under Graduates. Vayu Education



UNIT II
National Action Plan on Climate Change (NAPCC) - National Mission on Sustainable Energy, National Mission on Sustainable Habitat, National Mission on Sustainable Agriculture, National Mission on Sustainable Water Management - Ecological Balance, National Mission on Sustainable Urban Management.

UNIT III
Environmental Governance and Institutions: National Commission on Environment, National Environmental Policy, National Environmental Action Plan, National Environmental Quality Standards (NEQS), National Environmental Quality Standards (NEQS) - Air, National Environmental Quality Standards (NEQS) - Water, National Environmental Quality Standards (NEQS) - Soil, National Environmental Quality Standards (NEQS) - Noise, National Environmental Quality Standards (NEQS) - Odour, National Environmental Quality Standards (NEQS) - Radiation, National Environmental Quality Standards (NEQS) - Light, National Environmental Quality Standards (NEQS) - Vibration, National Environmental Quality Standards (NEQS) - Electromagnetic Interference (EMI), National Environmental Quality Standards (NEQS) - Radio Frequency Interference (RFI), National Environmental Quality Standards (NEQS) - Thermal, National Environmental Quality Standards (NEQS) - Noise and Vibration, National Environmental Quality Standards (NEQS) - Light and Radiation, National Environmental Quality Standards (NEQS) - Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI), National Environmental Quality Standards (NEQS) - Thermal, National Environmental Quality Standards (NEQS) - Noise and Vibration, National Environmental Quality Standards (NEQS) - Light and Radiation, National Environmental Quality Standards (NEQS) - Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI).

UNIT IV
Environmental Quality Standards (EQS) for Air, Water, Soil, Noise, Radiation, Light, Vibration, Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI).

UNIT V
Environmental Policy and Law (India): National Environmental Policy, National Environmental Action Plan, National Environmental Quality Standards (NEQS), National Environmental Quality Standards (NEQS) - Air, National Environmental Quality Standards (NEQS) - Water, National Environmental Quality Standards (NEQS) - Soil, National Environmental Quality Standards (NEQS) - Noise, National Environmental Quality Standards (NEQS) - Odour, National Environmental Quality Standards (NEQS) - Radiation, National Environmental Quality Standards (NEQS) - Light, National Environmental Quality Standards (NEQS) - Vibration, National Environmental Quality Standards (NEQS) - Noise and Vibration, National Environmental Quality Standards (NEQS) - Light and Radiation, National Environmental Quality Standards (NEQS) - Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI), National Environmental Quality Standards (NEQS) - Thermal, National Environmental Quality Standards (NEQS) - Noise and Vibration, National Environmental Quality Standards (NEQS) - Light and Radiation, National Environmental Quality Standards (NEQS) - Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI).

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CENTRAL UNIVERSITY OF JAMMU
Syllabus for PhD in Environmental Sciences

Semester-I

Academic Year 2019-20

Subject course Code: PHEVS1C002.T

Subject Course Title: Advanced tools and techniques in Environmental Sciences

Duration of examination: 3 Hours

Maximum Marks: 100

Credits:4

Contact Hours/Week: 4

UNIT I:

Standard protocol for sampling of air, water and soil for chemical analysis; Gravimetric analysis and Volumetric analysis; Principle, structure and working of pH meter; Conductivity meter; Nephelometer; Bomb calorimeter; Sound level meter; thermal gravimetric analysis (TGA)

UNIT II:

Basics of chromatography; Paper chromatography, thin layer chromatography and column chromatography; Gas chromatography (GC), Gas chromatography-mass spectrometry (GC-MS); High Pressure Liquid Chromatography (HPLC); Ion chromatography

UNIT III:

Basics of spectrometry; UV-Visible spectrophotometer, Flame photometer, Atomic absorption spectroscopy (AAS); Inductively coupled plasma atomic emission spectroscopy (ICP-AES); Inductively coupled plasma mass spectrometry (ICP-MS)

UNIT IV:

Basics of microscopy; Phase contrast, Fluorescent and Electron microscopy; Scanning electron microscope (SEM); Transmission electron microscope (TEM); X-ray florescence (XRF); X-ray diffraction (XRD); Nuclear magnetic resonance spectroscopy (NMR); Fourier transform infrared (FTIR); Eletrophoresis

UNIT V:

Earth approximation and coordinate system, data types and management in geospatial techniques, GPS functioning to estimate the position, Digitization, editing and map preparation in GIS platform, Sensor and data processing in remote sensing, Spectral signature, Image enhancement, Vegetation type and hazard zone mapping using remote sensing technique

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Suggested Readings

1. An Introduction to Geographical Information Systems, by Ian Heywood
2. Text book of quantitative chemical analysis by Vogel, I & Mendham, J. Vogel's
3. Practical Handbook of spectroscopy by James W. Robinson
4. Quantifying Uncertainty in Analytical Measurement by Ellison and William
5. The Fitness for purpose of Analytical methods by Eurachem Guid

CENTRAL UNIVERSITY OF JAMMU

Syllabus for PhD in Environmental Sciences

Semester-I

Academic Year- 2019-20

Subject course Code: PHEVS1E001T

Subject Course Title: Advanced Atmospheric Chemistry

Duration of examination: 3 Hours

Maximum Marks: 100

Credits: 4

Contact Hours/Week: 4

UNIT-I:

The Layers of the Atmosphere and their chemical composition, Expressing the amount of a Substance in the Atmosphere, Variation of Pressure and Temperature with Height in the Atmosphere, Energy Balance for Earth and Atmosphere, Beer-Lambert Law and the concept of Optical Depth.

UNIT-II:

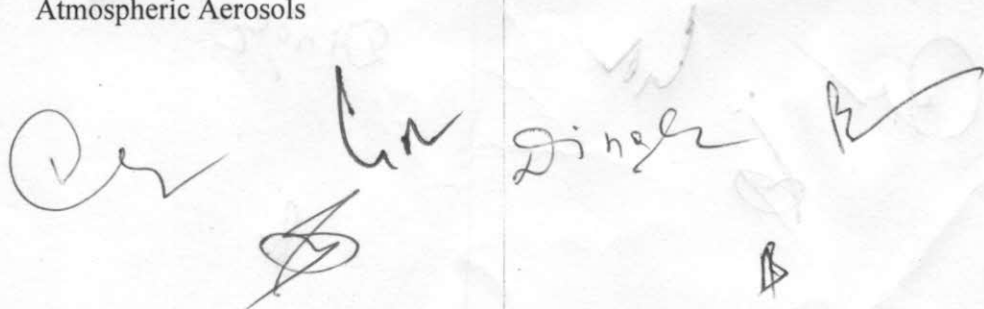
Chemistry of Nitrogen in troposphere: Sources and chemistry of NO_x and NO_y , Chemistry of Sulphur in troposphere: Sources and chemistry of SO_x , Chemistry of Carbon in troposphere: Sources and chemistry of CO , CO_2 , CH_4 and Non-methane Hydro Carbons Chemistry of Oxygen in troposphere: ODD oxygen chemistry, formation of Ozone and OH^* radicals, Influence of Meteorology on the concentration of Atmospheric constituents

UNIT-III:

Physical Properties and Chemical Composition of Atmospheric Aerosols, Interaction of Light with Particles, Role of Atmospheric Aerosols in Global Climate Change

UNIT - IV:

Techniques for Sampling of Atmospheric Gases, Sampling of Atmospheric Aerosols, Real-Time Monitoring Techniques for Atmospheric Gases, Real-Time Monitoring Techniques for Atmospheric Aerosols

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UNIT - V:

Analytical techniques in atmospheric chemistry: Elemental (CHNSO) Analyzer, Thermo-Optical (TOR/TOT) Carbon Analyzer, Atomic Absorption Spectrophotometer (AAS), Inductively Coupled Plasma - Atomic Emission Spectrophotometer (ICP-AES), and Inductively Coupled Plasma - Mass Spectrometer (ICP-MS), Ion Chromatography System (ICS), Gas Chromatography System (GCS) and Gas Chromatography - Mass Spectrometer (GC-MS), X-Ray Diffractometer (XRD) and X-Ray Fluorescence Spectrometer (XRF)

Text Books:

1. Finlayson-Pitts, B.J., Pitts J.N., J., (2000): Chemistry of the upper and lower atmosphere-Theory experiments and applications. Academic Press, US.
2. Seinfeld, J.H., Pandis, S.N., (2006): Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, Atmospheric Chemistry and Physics.
3. Wallace John M. Jr., Peter V. Hobbs (2006): Atmospheric Science: An Introductory Survey, 2nd Edition, Academic Press, ISBN: 978-0127329512
4. Frederick K. Lutgens, Edward J. Tarbuck (2010): The Atmosphere: An Introduction To Meteorology, Phi (Prentice-hall New Arrivals), ISBN: 978-8120344150
5. Gilbert, M. Masters & Ela, W. P. (2007): Introduction to Environmental Engineering and Science. PHI learning Pvt Ltd.
6. Standard Methods for Examination of Water and Waste Water. APHA, AWWA, WEF, 21 Ed, 2005
7. Vogel, I & Mendham, J. (2000): Vogel's Text book of quantitative chemical analysis. Prentice Hall Publication.

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CENTRAL UNIVERSITY OF JAMMU

Syllabus for PhD in Environmental Sciences

Semester-I

Academic Year 2019-20

Subject course Code: PHEVS1EQ.02T

Subject Course Title: Advances in Microbiology and Bioprocesses

Duration of examination: 3 Hours

Maximum Marks: 100

Credits: 4

Contact Hours/Week: 4

Unit- 1

Historical overview of microbiology, Industrially important microorganisms, Isolation, purification and preservation of microbes techniques; Cell culture techniques- aseptic transfer; Methods of determining microbial growth; factors affecting microbial growth; types of microbial growth.

Unit-II

Fermentation equipment's and its uses, Fermenter designs, Aerobic and anaerobic fermentation, Types of fermentation: batch, continuous, submerged, solid state, Consolidated bioprocessing.

Unit-III

Landfill classification, design and operation of sanitary landfills, Landfill bioreactors, Methane mitigation: biofiltration and biotarp, Biosorption; microbial biosorption; mechanism of biosorption and bioaccumulation, Case studies related to bioremediation.

Unit-IV

Environmental clean-up technologies, Biodegradation: Factors affecting on process of biodegradation, Microbial degradation of naturally occurring compounds- cellulose, lignin,

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hydrocarbons, Biodegradation of oil and petroleum products, Biodegradation of agricultural chemicals.

Unit-V

Microbes in ethanol production from biomass, Microbes in biogas production, Microbes in reclamation of polluted sites, Microbes in human welfare, Vermi-composting.

Reference Books:

1. Prescott, L. M., Harley, 3. P., and Klein, D. A., Microbiology, 2nd Edition, Wm. C. Brown Publishers, Dubuque, Iowa, 1993
2. Purohit, S.S., Microbiology- Fundamentals and Applications, 7th Edition, Agrobios (Inida) Publisher, 2017
3. Stanbury, P.F., Whitaker, A., Hall, S.J. Principles of Fermentation Technology, 3rd Edition, 2016
4. Martin Alexander. Biodegradation and Bioremediation. Academic Press; 2nd edition (April 15, 1999)
5. Das, S., Microbial Biodegradation and Bioremediation. Elsevier press, 1st edition, 2014

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CENTRAL UNIVERSITY OF JAMMU
Syllabus for PhD in Environmental Sciences

Semester-I

Academic Year 2019-20

Subject course Code: PHEVS1E003T

Subject Course Title: Advances in Geochemistry

Duration of examination: 3 Hours

Credits: 4

Maximum Marks: 100

Contact Hours/Week: 4

Unit I:

Primary differentiation of the earth and the formation of crust, mantle and core. Weathering and soil formation, Sea water; Components of marine sediments, Isotope Geochemistry: stable Isotopes, Radioactive isotopes; Physical properties of sediments, Oxygen and Redox chemistry, Distribution of element as provenance Indicator.

Unit II:

Porewater alkalinity Titration, Chemistry of natural waters, physical chemistry of dissolved materials in water, Eh, pH and stability diagram, Transport processes; sediment diagenesis, sediment organic geochemistry, processes at the sediment water interface, Grain size Analysis, Organic matter as provenance indicator.

Unit III:

Geochemical classification of elements; abundance of elements in the bulk earth, crust, hydrosphere, atmosphere and biosphere; Biogeochemical processes in sediments, Carbon and nutrient remineralization, Geochemical indicators of Environment change, Global cycles of Carbon and Sulfur, sedimentation, effects of modern agriculture on sediment and soil geochemistry

Unit IV:

Modern Analytical Methods in Geoscience; Bulk (Non-Position Sensitive) methods: Classical Wet Chemical Methods, AAS, AES, XRFA, MS. Beam(Position-Sensitive) Methods; SIMS, LA-ICP-AES, LA-ICP-MS, EPMA.

Unit V:

Sampling and Geochemical sample preparation. ACNK and ACNKFM Diagrams, Interpretation of XRD, XRF, ICP-OES, ICP-MS and IC data for Environmental components (Rock, Sediment and Water); Health aspects of sediment geochemistry in modern environment,

Suggested Readings:

1. Potts, P.J. A Handbook of Silicate Rock Analysis, Blackie, London, 1987.
2. Thompson, M. and Walsh, J.N. A Handbook of Inductively Coupled Plasma Spectrometry, Blackie, London, 1983.
3. Van Loon, J.C. Analytical Atomic Absorption Spectroscopy, Academic Press, London, 1980.

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4. Jeffery, P.G. and Hutchinson, D. Chemical Methods of Rock Analysis, Pergamon Press, Oxford, 1981.
5. Rollinson, H.R. Using Geochemical Data, Longman, New York, 1993
6. William M. White, Geochemistry; Wiley-Blackwell
7. Press and Siever, The Earth; W.H. Freeman
8. Skinner & Porter, The Dynamic Earth; Wiley
9. Mcsween, Richardson, Uhle, Geochemistry Pathways and Process; Columbia University Press.
10. Ray C. Lindholm: A Practical Approach to Sedimentological Analysis

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CENTRAL UNIVERSITY OF JAMMU
Syllabus for PhD in Environmental Sciences

Semester-I

Academic Year 2019-20

Subject course Code: PHEVS1E004T

Subject Course Title: Atmospheric Processes and Climate Change

Duration of examination: 3 Hours

Maximum Marks: 100

Credits: 4

Contact Hours/Week: 4

Unit-I

Structure and composition of the atmosphere, Humidity Parameters, Virtual Temperature, Stable and Instable atmosphere, Entropy, Potential Temperature, Equivalent Potential Temperature, Thermodynamic Diagrams. Precipitation process.

Unit-II

Tropical Meteorology: Hadley cell, trade winds, trade wind inversion, tropical convection, equatorial trough, ITCZ, easterly waves, tropical weather events, quasi-biennial oscillation (QBO). Monsoon, Rossby Waves, Madden-Julian oscillation(MJO), Elnino and Southern Oscillation (ENSO).

Unit-III

Boundary layer evolution and properties, Taylor's hypothesis, Eddy transport of momentum, Heat and moisture, TKE Budget; Stability concepts-Richardson number, Obhukhov length, Ekman layer, Boundary-layer profiling.

Unit-IV

Atmospheric Radiation and scattering (Raleigh and Mie scattering), Absorption spectra of atmospheric gases, Aerosols: Sources and Sinks, Characterisation of Aerosols, Reynold's number, Direct and Indirect Radiative Effects of Aerosols, Aerosol Measurement Techniques, Satellite Remote Sensing of Aerosols, Aerosols and Regional Climate

Unit-V

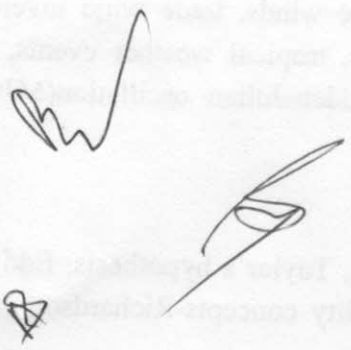
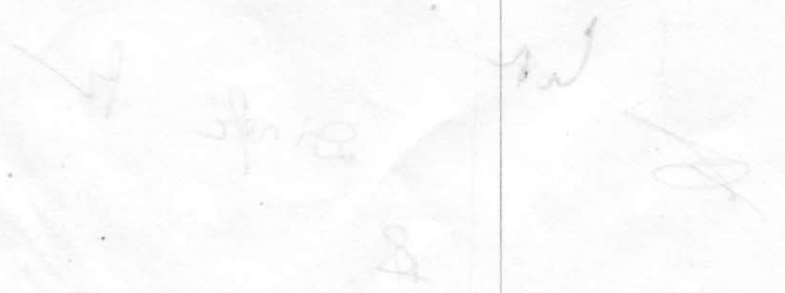
Climate system, factors for climate change, factors across different time scales and their interaction, climate modelling, Global circulation Models (GCM), Basic concepts of numerical weather prediction, Global Dimming versus Global Warming, Potential social, economic and environmental consequences of climate change.

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Suggested Readings:

1. Monsoon Meteorology by C.P. Chang & T.N. Krishnmoorthy
2. Mesoscale Meteorological Modelling by Roger A. Pielke
3. Mesoscale Atmospheric Circulation by B.W. Atkinson
4. Atmospheric Turbulence by Panofsky and J.A. Dutton.
5. Introduction to Boundary Layer Meteorology" Stull
6. The Atmospheric Boundary Layer by R.M. Stewart, WMO-523
7. Climate Change: The Science of Global Warming and Our Energy Future by Edmond Mathez
8. Tropical Meteorology Volume I & II by G.C. Asnani
9. Synoptic Meteorology by M.Kurz

Dineja

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Ph.D.Course work: Specialized subject (Newly Introduced)
Syllabus for the Ph.D. Programme in Environmental Sciences
Applicable for the Academic year 2019-2020
Subject Course Code No. PHEV51E005T

Subject Course Title: Bioenergy and Nanomaterials **Duration of Examination: 3 Hours**
Maximum Marks: 100 **Credits: 4** **Contact Hours / Week: 4**

UNIT-1 : Basics of Biomass and bioenergy

- 1.1. Biomass– types and potential; Energy crops.
- 1.2. Bioconversion processes: Biomass characterization; Biomass pyrolysis and gasification; Composting, Fermentation
- 1.3. Biofuels: Type of feedstocks for biofuels; Pellets and bricks of biomass; Biomass based thermal power plants; Biomass as boiler fuel;
- 1.4. Social, economic and ecological implications of biomass energy.

UNIT-2 : Waste and their treatment options

- 2.1. Waste treatment and disposal: Aerobic composting, incineration, different type of incineration; Advantages and disadvantages
- 2.2. Land-fill classification, types, methods, layout and preliminary design of landfills: movement and control of landfill leachate and gases, Advantages and disadvantages
- 2.3. Agricultural residues and wastes including animal wastes; industrial wastes; municipal solid wastes; waste processing-size reduction (Incinerators, gasifiers and digestors) and separation;
- 2.4. Waste management hierarchy: waste minimization and recycling processes of solid waste.

UNIT-3: Hydrogen: Future energy source

- 3.1. Introduction of hydrogen energy systems: Properties of hydrogen as fuel,
- 3.2. Hydrogen Production methods-current uses, general introduction to infrastructure requirement, optimized process parameters and hydrogen production plants.
- 3.3. Fuel cells: applications and types. Relative merits and demerits.
- 3.4. Hydrogen energy storage: materials; merits and demerits

UNIT-4 : Bioenergy options

- 4.1. Biogas: availability of raw materials; Production methods, and different type of digesters, operational parameters
- 4.2. Bio-diesel: availability of raw materials; Production methods, and different type of digesters, operational parameters; Fuel quality standards and properties.
- 4.3. Applications of Bioenergy, Potential in India: Policies and Challenges
- 4.4. Environmental impacts: advantages and disadvantages

UNIT-5 : Nanomaterials: Fundamentals and Applications

- 5.1. Screening of nanomaterials for understanding potential effects to human health and the environment. Mapping of the environmental fate of nanomaterials. Relationships between key properties of nanomaterials and their environmental fate, bio-distribution, toxicity.
- 5.2. Environmental Pollution by Nanoparticles: Health impact, safety and toxicological effects transport of nanomaterials in soil/sediments. Physical and chemical properties of nanomaterials influencing their behavior in the environment and in biological systems.
- 5.3. Application to Environment: Nanotechnology for waste reduction and improved energy efficiency.
- 5.4. Nanotechnology based water treatment strategies: Nanoporous polymers and their applications in water purification

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References:

- [1] Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN:9780470539675, Publisher: John Wiley & Sons, Publication Date: June 2010.
- [2] Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1- 57808-200-1; 2002
- [3] Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.
- [4] Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987.
- [5] Waste-to-Energy by Marc J. Rogoff, DEC-1987, Elsevier, ISBN-13: 978-0-8155-1132-8, ISBN-10: 0-8155- 1132-9.
- [6] Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
- [7] Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.
- [8] Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.
- [9] Robert Green, From Waste to Energy, Cherry Lake Pub. ISBN: 1602795096, 2009.
- [10] G. Evans, Biowaste and Biological Waste Treatment, 2005 [11]. Biogas from waste and renewable resources, by Dieter D. And Angelika S. Wiley-Vch Publication 2010.
- [11]. Environmental Chemistry for a Sustainable World, Volume 1: Nanotechnology and Health Risk Editors: Lichtfouse, Schwarzbauer, Robert
- [12]. Advances in Nanotechnology and the Environment, Juyoung Kim, CRC Press, Taylor and Francis Group

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