BHARATHIDASAN UNIVERSITY  **TIRUCHIRAPPALLI - 620 024.**

B.Sc. ENVIRONMENTAL SCIENCE

CHOICE BASED CREDIT SYSTEM –

LEARNINIG OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

(NAAN MUDHALVAN SCHEME was implemented from 2nd to 6th Semester)

Sem.	Part	Courses	Title	Ins. Hrs.	Credits	Exam Hours	Marks		Total
							Int.	Ext.	
I	I	Language Course – I (Tamil $/Other Languages + #)		6	3	3	25	75	100
	II	English Course - I		6	3	3	25	75	100
	III	Core Course – I (CC)	Concepts of Environment	5	5	3	25	75	100
		Core Practical – I (CP)	Environment and Ecology	4	4	3	40	60	100
		First Allied Course – I (AC)	Biology I	4	4	3	25	75	100
		First Allied Practical (AP)	Biology	3	-	-	-	-	-
	IV	Value Education		2	2	3	25	75	100
	TOTAL			**30**	**21**	**-**	**-**	**-**	**600**
II	I	Language Course - II (Tamil $/Other Languages + #)		6	3	3	25	75	100
	II	English Course - II		4	3	3	25	75	100
	III	Core Course – II (CC)	Biodiversity and Conservation	5	5	3	25	75	100
		Core Practical – II (CP)	Ecology, Biodiversity and Conservation	4	4	3	40	60	100
		First Allied Practical (AP)	Biology	3	2	3	40	60	100
		First Allied Course – II (AC)	Biology II	4	4	3	25	75	100
		Add on Course – I ##	Professional English – I	6*	4	3	25	75	100
	IV	Environmental Studies		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Language Proficiency for Employability - Effective English	2	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**900**

III	I	Language Course – III (Tamil $/Other Languages + #)		6	3	3	25	75	100
	II	English Course - III		6	3	3	25	75	100
	III	Core Course – III (CC)	Environmental Pollution	5	5	3	25	75	100
		Core Practical - III (CP)	Air and Soil Pollution	4	4	3	40	60	100
		Second Allied Course – I (AC)	Chemistry I	4	4	3	25	75	100
		Second Allied Practical (AP)	Volumetric and Organic Qualitative Analysis	3	-	-	-	-	-
		Add on Course – II ##	Professional English - II	6*	4	3	25	75	100
	IV	Non-Major Elective I @ - Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level **or** b) Special Tamil if Tamil language was studied upto 10^{th} & 12^{th} std.		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Digital Skills for Employability – Microsoft Digital Skills	-	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**800**
IV	I	Language Course –IV (Tamil $/Other Languages + #)		6	3	3	25	75	100
	II	English Course – IV		6	3	3	25	75	100
	III	Core Course - IV (CC)	Natural Resources	5	5	3	25	75	100
		Core Practical - IV (CP)	Water Pollution	4	4	3	40	60	100
		Second Allied Practical (AP)	Volumetric and Organic Qualitative Analysis	3	2	3	40	60	100
		Second Allied Course – II (AC)	Chemistry II	4	4	3	25	75	100
	IV	Non-Major Elective II @ - Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level **or** b) Special Tamil if Tamil language was studied upto 10^{th} & 12^{th} std.		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NM) @@	Employability Skills - Employability Skills	-	2	3	25	75	100
	TOTAL			**30**	**25**	**-**	**-**	**-**	**800**

V	III	Core Course - V (CC)	Environmental Microbiology and Biotechnology	5	5	3	25	75	100
		Core Course – VI (CC)	Environmental Sanitation	5	5	3	25	75	100
		Core Course – VII (CC)	Sustainable Development	5	5	3	25	75	100
		Core Practical -V (CP)	Environmental Microbiology	4	4	3	40	60	100
		Major Based Elective – I (Any one)	1. Climate Change and its Impact 2. Global Warming and Issues	5	4	3	25	75	100
	IV	Skill Based Elective I	Environmental Education and Awareness	4	2	3	25	75	100
		Soft Skills Development		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Advanced Technology for Employability in Life science – Organic Food Production Techniques	-	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**800**
VI	III	Core Course - VIII (CC)	Waste Management	6	5	3	25	75	100
		Core Course - IX (CC)	Environmental Toxicology	6	5	3	25	75	100
		Core Practical – VI (CP)	Environmental Toxicology	4	4	3	40	60	100
		Major Based Elective II (Any one)	1. Eco Tourism 2. Environmental Law and Policy	5	4	3	25	75	100
		Project		4	3	-	20	80	100
	IV	Skill Based Elective – II	RRR Strategies	4	2	3	25	75	100
	V	Gender Studies		1	1	3	25	75	100
		Extension Activities **		-	1	-	-	-	-
	VI	Naan Mudhalvan Scheme (NMS) @@	Food Safety & Quality Management	-	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**800**
GRAND TOTAL				**180**	**158**	**-**	**-**	**-**	**4700**

$ For those who studied Tamil upto 10th +2 (Regular Stream).

+ Syllabus for other Languages should be on par with Tamil at degree level.

Those who studied Tamil upto 10th +2 but opt for other languages in degree level under Part- I should study special Tamil in Part – IV.

The Professional English – Four Streams Course is offered in the 2nd and 3rd Semester (only for 2022-2023 Batch) in all UG Courses. It will be taught apart from the Existing hours of teaching / additional hours of teaching (1 hour /day) as a 4 credit paper as an add on course on par with Major Paper and completion of the paper is must to continue his / her studies further. (As per G.O. No. 76, Higher Education (K2) Department dated: 18.07.2020).

* The Extra 6 hrs / cycle as per the G.O. 76/2020 will be utilized for the Add on Professional English Course.

@ NCC Course is one of the Choices in Non-Major Elective Course. Only the NCC cadets are eligible to choose this course. However, NCC Course is not a Compulsory Course for the NCC Cadets.

** Extension Activities shall be outside instruction hours.

@@ Naan Mudhalvan Scheme.

SUMMARY OF CURRICULUM STRUCTURE OF UG PROGRAMMES

Sl. No.	Part	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	I	Language Courses	4	12	400
2.	II	English Courses	4	12	400
3.	III	Core Courses	8	40	800
4.		Core Practical	7	29	700
5.		Allied Courses I & II	4	16	400
6.		Allied Practical	2	4	200
7.		Major Based Elective Courses	2	8	200
8.		Add on Courses	2	8	200
9.		Project	1	3	100
10.	IV	Non-Major Elective Courses (Practical)	2	4	200
11.		Skill Based Elective Courses	2	4	200
12.		Soft Skills Development	1	2	100
13.		Value Education	1	2	100
14.		Environmental Studies	1	2	100
15.	V	Gender Studies	1	1	100
16.		Extension Activities	1	1	0
17.	VI	Naan Mudhalvan Scheme	5	10	500
	Total		**48**	**158**	**4700**

PROGRAMME OBJECTIVES:

- Enhance the ability to apply this knowledge and proficiency to find solutions relating to environmental concerns of varied dimensions of present times.
- To develop analytical thinking and problem-solving skills needed for various entrance and competitive examinations and Post Graduate Studies
- To train students in laboratory skills and handling equipment along with soft skills needed for placement.
- Motivate graduates to appreciate that they are an integral stakeholder in the environmental management of India irrespective of their future jobs or working.
- Help graduates to understand the concerns related to Sustainable Development Goals (SDGs) and the Indian obligations.

PROGRAMME OUTCOMES:

- Student are able to acquire knowledge, competent professionals with a strong foundation of Environmental Science
- The learners will be able to become effective scientific communicators/collaborators in multidisciplinary teams providing technical leadership to engage with the challenging environmental problems of local, national and global nature.
- They can opt for higher studies in plant and animal sciences as the environmental science is multidisciplinary in nature.
- The students will be eligible to appear for various competitive examinations and pursue higher education.
- Students will understand about how the subject knowledge helps in solving various social, economic and environment related problem
- To bring sensitization towards the environment and also increase student competency & employability.

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First Year **CORE COURSE I** **Semester I**

CONCEPTS OF ENVIRONMENT

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES

- To know the physical environment encompassing atmosphere, hydrosphere, lithosphere and biosphere.
- To realize the importance of interactions among various spheres and appreciate the inter relationships among them.

UNIT – I:

Environment: Definition and importance; Principles and Scope; Continents; landmasses. Earth and Sun relationship: earth in the solar system, earth's planetary motions – rotation and revolution, seasonality, solstices and equinoxes.

UNIT – II:

Atmosphere: Composition of air- Layers of Atmosphere, Ozone layer – Radiation balance, Spectrum - Horizontal distribution of temperature and pressure, Global Circulation.

UNIT – III:

Hydrosphere: Sources of water – importance of water, hydrologic cycle - Precipitation and types of precipitation, ocean currents – generation of ocean currents, types of ocean currents; Distribution of fresh water.

UNIT – IV:

Lithosphere: Earth's crust and its composition-Internal structure of the earth-Soil texture, types of rocks- Types of soil, process of soil formation and soil nutrients.

UNIT – V:

Biosphere: Concept and definition; Types of Biomes and their distribution. Biogeographic zones: Phytogeographic zones, Zoogeographic zones.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Earth Day, World Environment Day, Ocean microplastics contamination, Biomass conversion technologies – energy from waste – Briquetting – Energy Villages.

REFERENCES:

1. De, A. K. (2017), Environmental Chemistry, New Age International (P).
2. Stanley E. Manahan (2010), Fundamentals of Environmental Chemistry: Taylor & Francis.
3. Choudhary, C. K. (2009), Basics of Environmental Chemistry, Anmol publication private limited.
4. Julian E. Andrews et. al., (2004), An Introduction to Environmental Chemistry, Blackwell Publisher.
5. Rai, G. D. (2014), Non-Conventional Energy Sources, Khanna Publishers, New Delhi.
6. Botkin, D.B. and Keller, E.A., Environmental Science: Earth as a Living Planet, John Wiley and Sons, New Delhi, 2011.
7. Cunningham, W. P. and Saigo, B.W., Environmental Science – A Global Concern, Eighth Edition. WCB/McGraw Hill, New York, 2007.
8. McKinney, M.L., Schoch, R. and Yonavjak, R.M., Environmental Science Systems and Solutions, Jones &Bartlett Publishing Inc., Delhi, 2007.
9. Sharma, P.D., Ecology and Environment, Seventh Edition, Rastogi Publication, Meerut, 2004.
10. Santra, S.C., Environmental Science, Second Edition, New Central Book Agency (P) Ltd., Kolkata, 2010.
11. Joseph, K. and Nagendran, R., Essentials of Environmental Studies, Pearson Education Publisher, Delhi, 2004.
12. Purohit, S.S., Shammi, Q.J. and Agarwal, A.K., A Textbook of Environmental Science, Students Edition, Jodhpur, 2004.
13. Reddy, A.M., Textbook of Environmental Science and Technology, BSP Books Pvt. Ltd., Hyderabad, 2005.
14. Anjaneyulu, Y., Introduction to Environmental Science, BSP Books Pvt. Ltd., Hyderabad, 2009.
15. Lal, D.S. Climatology, Sharda Pustak Bhawan, Allahabad, 2003.
16. Chapin III, F.S., Matson, P.A. and Vitousek, P.M., Principles of Terrestrial Ecosystem Ecology, Springer, New Delhi, 2012.
17. Bloom, A.L., Geomorphology – A Systematic Analysis of Late Cenozoic Landforms, Third Edition, Pearson Education, Singapore, 2003.
18. Dayal, P., A Textbook of Geomorphology, Shukla Book Depot, Patna, 2001.
19. Singh, S., Environmental Geography, Prayag Pustak Bhawan, Allahabad, 2002.
20. http://www.envfor.nic.in
21. http://www.ecology.edu

COURSE OUTCOMES:

- The learner will understand the structure and function of our life supporting environment.
- One can understand the fundamentals of Environmental sciences.
- Student would learn the basic concepts of population and community ecology
- Student gains knowledge on the basic concepts of eco systems and its components
- One can clearly understand the concepts of food chain, food web and energy flow in an ecosystem.

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First Year **CORE PRACTICAL I** **Semester I**

ENVIRONMENT AND ECOLOGY

Code: **(Practical)** **Credit: 4**

COURSE OBJECTIVES:

- To understand the major ecological concepts and complex interrelationships in nature.
- To expose the students in estimation of species diversity and to compare biodiversity indices for understanding the ecology

EXPERIMENTS

1. Determination of requisite size of the quadrant for vegetation analysis.
2. Determination of the frequency distribution of plants in a piece of vegetation by quadrat method
3. Temporary wet amount technique for the observation of living organism
4. Identification of soil texture-clay, sand, loamy
5. Diagrammatic representation of solar, lunar, eclipses, day and night
6. Submission of 10 herbarium sheets with proper field note book
7. Estimation of species diversity by Shannon-weiner diversity index method.

REFERENCES:

1. Trivedy, R K., Goel, P. K and Trisal, L. Practical Methods in Ecology and Environmental Sciences. Environmental Publications, Karad, 1987.
2. HowardS. Peavy., Donald R. Rowe and George Tchobanoglous, Environmental Engineering. Indian Edition,2017
3. Sawyer, C. N. and McCarty, P. L. Chemistry for Environmental Engineering, McGraw Hill International, 1978.
4. Margesin R and Schinner. Manual of Soil Analysis – Monitoring and Assessing Bioremediation. Springer –Verlag Berlin Heidelberg, 2005.

COURSE OUTCOMES:

- Students to gain knowledge related on methods from ecological and physical sciences and their application in environmental problem solving.
- Explain the collection, handling and preservation of the environmental samples
- Analyze the physico- chemical parameters of soil
- Compare the results with the standards

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First Year **FIRST ALLIED COURSE I BIOLOGY I** **Semester I**

Code: **(Theory)** **Credit: 4**

PLANT DIVERSITY AND PHYSIOLOGY, MUSHROOM TECHNOLOGY AND PLANT BIOTECHNOLOG

COURSE OBJECTIVES

- To expose the diversity of plant kingdom and their salient features
- To acquire skills for engaging themselves in self-employment especially in the broad field of Mushroom Culture.
- To expose various avenues of opportunities in the field of plant biotechnology considering its recognition, importance and utility value.

UNIT – I:

Algae: General characteristics of algae and its importance. Structure, reproduction and life cycle of *Nostoc, Chlorella, Oedogonium, Ectocarpus* and *Polysiphonia.*

Fungi: General characteristics of fungi and its importance. Structure of *Albugo*and *Penicillium*.

UNIT - II:

Bryophytes: General characteristics of bryophytes. Structure, reproduction and life cycle of *Ricciaand Polytrichium*.

Pteridophytes: General characteristics of pteridophytes. Structure, reproduction and life cycle of *Lycopodium.*

Gymnosperms: General characteristics of gymnosperms and its importance. Structure, reproduction and life cycle of *Cycas.*

UNIT - III:

Plant Physiology: Absorption of water. Photosynthesis – Light and dark reaction (C_3 cycle only). Respiration. Plant movements.

UNIT - IV:

Mushroom Technology: Mushroom: Introduction, nutritive value and importance of mushrooms. Cultivation of Oyster mushroom - spawn preparation, preservation of mushrooms, and mushrooms recipes.

UNIT - V:

Plant Biotechnology: Plant tissue culture - basic principles, M.S. medium preparation, Callus culture and regeneration

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Biodiversity, Hot Spots of Biodiversity, Biogeographical classification of India, CBD, UNEP

REFERENCES:

1. Chang, T.S. and Hayes, W.A. 1978. The Biology and Cultivation of Edible Mushrooms. Academic Press, New York.
2. M.C. Nair, C. Gokulapalan and Lulu Das, 1997. Topics on Mushroom Cultivation. Scientific Publishers, Jodhpur, India.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). *Introductory Mycology* (4th edition). John Wiley and Sons (Asia), Singapore.
4. Alice, D., Muthusamy and Yesuraja, M. (1999). *Mushroom Culture*. Agricultural College, Research Institute Publications, Madurai.
5. Dubey, R.C. (2013). A Textbook of Biotechnology. S. Chand & Company Ltd., New Delhi.
6. Ganguly A.K. (1971). General Botany, Vol. I. The New Book Stall, Calcutta.
7. Gupta, P.K. (1994). *Elements of Biotechnology*. Restogi Publications, Meerut.
8. Ignacimuthu, S. (1997). *Plant Biotechnology.* Oxford & IBM Publishing Co., New Delhi.
9. Jain, V.K. (1990). *Fundamentals of Plant Physiology*. S. Chand & Co., New Delhi.
10. Kalyan Kumar De. (1997). *Plant Tissue culture*. New central Book Agency, Calcutta.
11. Kumar, H.D. (1991). *A Textbook on Biotechnology.* East west press, New Delhi.
12. Marimuthu, T. (1991). *Oyster Mushroom*. Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
13. Nita Bhal (2000). *Handbook on Mushrooms Vol. I and II* (2nd Ed.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
14. Noggle, R. and Fritz (1989). Introductory Plant Physiology. Prentice Hall of India.
15. Pandey, B.P. (2001). *College Botany Vol. I: Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta*. S. Chand & Company Ltd., New Delhi.
16. Pandey, S.N. (1991). *Plant Physiology*. Vikas Publishing House (P) Ltd., New Delhi.
17. Parihar, P. (2014). A Textbook of Biotechnology. Argobios Publications, Jodhpur
18. Pathak, V.N. and Yadav, N. (1998). *Mushroom Production and Processing Technology*. Agrobios, Jodhpur.
19. Rao K.N. Krishnamurthy K.V. and Rao G. (1979). Ancillary Botany. Viswanathan Pvt. Ltd., Chennai.
20. Sethi, I.K. and Walia, S.K. (2011). *Text book of Fungi & Their Allies*. MacMillan Publishers Pvt. Ltd., Delhi.
21. Suman B.C. and Sharma V.P. (1990). Mushroom Cultivation and Uses. Agrobios (India), Jodhpur. Tripathi, D.P. 2005. *Mushroom Cultivation*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
22. www.unapcaem.org.
23. https://apeda.gov.in › apedawebsite › organic
24. https://extension.psu.edu/six-steps-to-mushroom-farming
25. https://www.mushroomcouncil.com/growing-mushrooms/six-steps-to-mushroom-farming

COURSE OUTCOMES:

- Students to gain hands on experience in mushroom cultivation, using different types of mushrooms.
- The learner ability to become self-employed / entrepreneur
- To gain knowledge on the marketing potential of the produced mushroom and composts.

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First Year **FIRST ALLIED PRACTICAL BIOLOGY** **Semester I**

Code: **(Practical)** **Credit: 2**

1. Micro preparations of algae, fungi, bryophytes, pteridophytes, gymnosperms and demonstrating their description and identity included in the syllabus.
2. Micro preparations of stem, root and leaf of dicot and their identification.
3. Micro preparation of anther and observation of ovules (permanent slides).
4. Description of the plants and salient features of the families included in the syllabus.
5. Dissection flower and construction of floral diagram.
6. Comment on simple experimental setups in plant physiology included in the syllabus.
7. Propagation techniques.

COURSE OUTCOMES:

- The course will enable students to know the earlier plants, their vegetative and their importance.
- Acquire basic skills on the plant taxonomy with special reference to Angiosperms
- Identify the angiosperms families with specific key characters; learn various advanced tools to study plant taxonomy.

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First Year **CORE COURSE II** **Semester II**

BIODIVERSITY AND CONSERVATION

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- This course deals with biodiversity conservation which is a major domain of Environmental Science.
- To learn about biodiversity and its importance in environmental biodiversity conservation and Management.
- To provide an understanding of the threats, hotspots and bio prospecting in an ecological and social contexts

UNIT - I:

Introduction to Biodiversity: Definition, concept and Types of biodiversity— Composition and Scales of Biodiversity: Genetic Diversity, Species/ Organismal Diversity, Ecological/ Ecosystem Diversity, Landscape/ Pattern Diversity, Agro biodiversity, Bio cultural Diversity and Urban Biodiversity.

UNIT - II:

Status of Biodiversity: Bio geographical Classification in India. Values of Biodiversity. Status of Biodiversity – Global, National and Local Status. Species Inventory, Hot-spots of Biodiversity. Endangered and Threatened Species. Bio prospecting, IUCN Categories – Red Data Book

UNIT – III:

Types and Significance of Biodiversity: Indirect/ Non-consumptive use value - Tangible Benefits- Food, Fiber, Fodder, Medicines, Construction Material. Intangibles- Pollination, Soil Development and Maintenance of Soil Fertility, Soil and Water Conservation. Existing Conservation Projects: Tiger, Rhino, Elephant, Turtles, Crocodiles, Birds; Coral Reefs and Mangroves. – Environmental Ethics, Anthropocentrism, Biocentrism, Ecocentrism and Religions

UNIT - IV:

Threats to Biodiversity: Habitat Alteration, Invasive Species, Pollution, Population Explosion, and Overexploitation of Resources- Habitat Destruction, Fragmentation, Transformation, Degradation and Loss: Causes, Patterns and Consequences on the Biodiversity of Major Land and Aquatic Systems Invasive Species Pathways, Biological Impacts on Terrestrial and Aquatic Systems. Extinction: Types of Extinctions, Processes Responsible for Species Extinction, Current and Future Extinction Rates, IUCN Threatened Categories, Sixth Extinction/Biological Crisis.

UNIT - V:

Biodiversity Conservation: Conservation and Management, Protection of Natural Habitats, National and International Protected Area, Current Practices in

Conservation - In *Situ* Conservation and *Ex Situ* Conservation of Threatened Species - Cryopreservation, Gene Banks, Gene Pool and Species Conservation. National Parks and Sanctuaries. Common Flora and Fauna in India, The Biological Diversity Act, 2002, Biological Diversity Rules, 2004. Agenda 21, Multilateral Treaties.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Field visit to Butterfly Conservation Park. An observation visit to Pachamalai area, Trichy. To study about marine bio-resources (MFR) Mukambu.

REFERENCES:

1. Mahaesh Prasad Singh, (2009), Biodiversity, APH Publishing corporation, New Delhi.
2. Arumugam, N. & Kumaresan, V. (2014), Environmental Studies Saras Publication, Kanyakumari.
3. Kumar, U., Asija, M.J. (2012), Biodiversity: principles & Conservation, 2ndEd., AGROBIOS (INDIA), Jodhpur
4. An Advanced Textbook on Biodiversity – Principles and Practice, Krishnamurthy, K.V (2003). Oxford and IBH Publishing, New Delhi.
5. Biodiversity – Strategies for Conservation, Dadhich L. K. and A.P. Sharma (2002), APH Publishing Corporation, New Delhi.
6. Biodiversity and Ecosystem functioning, Michael Lotaceer, Shaheed Naeen & P. Inchausti (2002). Oxford Press.
7. Biodiversity and Human Health, Aguirre, A. Alonso (2009), Eco Health, 6 (1), 153-156.
8. Biodiversity Conservation – In Managed Forest and Protected Areas, Kotwal, P.C. and S. Banerjee (2002). Agrobios, India.
9. Biodiversity, Science and Development, Francesco di castri (1996), Backhuys Publishers, The Netherlands.
10. Biodiverstiy, Supriyo Chakraburty (2007), Pointer Publishers.
11. Conservation of Biodiversity and Natural Resources. Singh, M.P., B.S. Singh and Soma S. Dey (2004), Daya Publishing House, Delhi.
12. Ecology and Field Biology, Smith R and Smith RM (2000),6th ed., Prentice Hall.
13. Ecology of Natural Resources, Ferancois Ramade (1991), John Wiley.
14. Ecology, Environmental and Resource Conservation, Singh JS, Singh SP and SR Gupta (2008), Anamaya Publishers, India
15. Ecology: from Individuals to Ecosystems, Begon M, Townsend CR & Harper JL (2006), John Wiley and Sons.
16. Environmental Biodiversity, P. R. Yadhav, Shudrata. R. Mishra (2004), Discovery
17. Fundamentals of Conservation Biology, Malcolm L. Hunter, Jr. (2002), Blackwell Science.
18. Global Biodiversity – Conservation Measure, Khan, T. I and Dhari N Al Ajmi (1999), Pointer Publishers, Jaipur.
19. Global Biodiversity – Status of the Earths Living Resources, Brian Groombridge (1992) Chapman & Hall, London.
20. Global Biodiversity and Environmental Conservation, T. I. Khanz (2000) Oxford Press.

21. Global Biodiversity, Sinha, R. K (1997), INA Shree Publishers, Jaipur.
22. The Biology of Biodiversity, Kato, M (1999), Springer Verlag, Tokyo.
23. Valuation and Conservation of Biodiverstiy, M. Markassen, R. Buse & H. Garrelts (2005), Springer.
24. www.biodiversityofindia.org
25. www.wwfindia.org
26. edugreen.teri.res.in/
27. intecol.org/
28. www.glomis.com/
29. www.cbd.int/health/
30. www.who.int

COURSE OUTCOMES:

- The student could understand the types of Biodiversity
- One could analyze economic values of loss of biodiversity
- The learner can obtain the knowledge of sustainable environment
- The student can identify the suitable technique for conservation of biodiversity
- The benefits both direct and indirect were taught to the learner.
- A detailed note on the ecosystems and habitats is taught
- One could understand the threats to biodiversity
- The student can Learn about National and international legal network framed for biodiversity conservation

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First Year | **CORE PRACTICAL II** | **Semester II**

ECOLOGY, BIODIVERSITY AND CONSERVATION

Code: | **(Practical)** | **Credit: 4**

COURSE OBJECTIVES:

- To understand the major ecological concepts and complex interrelationships in nature.
- To learn understanding related on Biodiversity of nature
- To expose the students in estimation of species diversity and to compare biodiversity indices for understanding the ecology

EXPERIMENTS:

1. Biodiversity assessment of forest tree community.
2. Quantitative inventory of Liana abundance and diversity in relation to host trees.
3. Forest Biomass calculation by allometric method.
4. Determination of carbon stock of woody plant species.
5. Nutrients cycling in forest: Soil sampling & Organic carbon analysis.
6. Belowground vegetation: Find root biomass determination.
7. Quantification of forest standing stock of litter and carbon analysis.

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First Year **FIRST ALLIED COURSE II BIOLOGY II** **Semester II**

Code: **(Theory)** **Credit: 4**

ANIMAL DIVERSITY, ADOPTATION AND BEHAVIOUR

COURSE OBJECTIVES:

- To comprehend and analyze the adaptive changes that have occurred in invertebrates & vertebrates
- To comprehend the genetics, anatomy, physiology and behavior along with other specialized fields of interest
- To recognize and describe the basic habit, habitat & behavior of chordates

UNIT – I DIVERSITY OF INVERTEBRATES AND CHORDATES:

Kingdom Animalia: Salient features - levels of organization: cellular, tissue, organ and organ system; Classification of major Invertebrata Phyla and Phylum Chordata up to classes - General characters and diversity of Major Invertebrata Phyla and Phylum Chordata with suitable examples.

UNIT – II BENEFICIAL INSECTS, VERMICULTURE AND PARASITOLOGY:

Detailed study: Earthworm –Cockroach- Pigeon. Economic importance of beneficial insects - Social life of honey bees. Brief study of Vermiculture, vermicomposting and its applications. Parasitology-Vector borne diseases– Malaria, Dengue.

UNIT – III ADAPTIVE RADIATION IN CHORDATES:

Biological significance of Migratory animals: Fishes, Birds and Mammals. Flight adaptations in vertebrates - Aquatic adaptations in birds and mammals; embryonic adaptation: Extra embryonic membrane structure in Reptiles and Birds. Adaptive radiations in chordates: Aquatic, terrestrial and arboreal. Bio indicators- microbes.

UNIT – IV ANIMAL BEHAVIOUR AND PHEROMONES:

Animal Behaviour: Stereotyped behaviour- instincts and motivation; Acquired behaviour: Pavlovian learning, trial and error learning. Pheromones and behaviour: types, significance – Pheromones with reference to insects and rodents.

UNIT – V SOCIAL BEHAVIOUR IN ANIMALS:

Social behaviour: Birds, primates. Biological rhythms: circadian, tidal, lunar, circannual rhythms. Types of communication in animals: visual, olfactory, tactile, verbal and non-verbal- Communication in bees and birds. mimicry and animal colorations.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Hots spots of India, Types of Biodiversity, Biogeographical classification, IUCN, Red Data Book

REFERENCES:

1. 1.Jordan E.L. and Verma P.S., Invertebrate Zoology,12thedn. Schand& Co. 1995.
2. Kotpal R.L., Agarwal, R.P.R., Khertarpa,Modern **Text Book** of Zoology-I – Rastogi
3. Publications.1989.
4. Ayyar E.K. Ananthakrishnan, T.N., **Outlines of Zoology**: **Invertebrata**, Vol-I and Vol-II Viswanathan Pvt. Ltd.1993.
5. Hoshang. S, Gundevia and Hare Govind Singh, **A textbook of Animal Behaviour**, Chand & Co., 1997.
6. Shukla G.S and Upadhay V.B., **Economic Zoology**, Rastogi Publications, 2004.
7. Jordan, E.L. and Verma P.S., **Invertebrate Zoology,** 12thedn. S.Chand& Co., 1995.
8. **Reptilia** (https://www.notesonzoology.com/phylum-chordata/garden-lizard/external-morphology-of-garden-lizard-with-diagram-chordata-zoology/8383)
9. **Vector borne diseases** (https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases)
10. **Apiculture** (https://www.sciencedirect.com/topics/earth-and-planetary-sciences/apiculture)

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Second Year **CORE COURSE III** **Semester III**

ENVIRONMENTAL POLLUTION

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To understand the various forms of pollution their causes, effects and control.
- To acquire the knowledge of chemical reactions taking places in the environment

UNIT - I:

Air pollution – Introduction – classification of air pollutants – primary and secondary, particulate and gaseous; Sources of air pollution – vehicles, industries – Cement plant, Limestone mining, volcanoes, dust storm; Effects of air pollution on – Man – Plants and Materials; green house effect – global warming – ozone depletion; Bhopal Gas disaster; Acid rain.

UNIT - II:

Water Pollution: Introduction – sources – point and non- point ; Oxygen demanding waste, industrial effluents and domestic sewage and its effects; Eutrophication, Bioaccumulation, Bioconcentration, Biomagnification, Ground water – Surface water – lake water – sea water; Water Quality standards.

UNIT - III:

Soil pollution: Sources of soil pollution - Effects of soil pollution; Pesticides in soil environment and their effects; Sediments; Biological magnification, pollution through mining; Control of soil pollution.

UNIT - IV:

Thermal pollution – Introduction; sources of thermal pollution – Nuclear power plants, Hydro electrical power plants, coal power plants; Effects of thermal pollution. Oil pollution – sources and effects – oil pollution and marine biota; flora and fauna, bio indicators.

UNIT - V:

Noise pollution: Sources – natural and manmade; Characteristics of sound – frequency, intensity, time of exposure, Intermittence; Effects of noise pollution – Man and materials; Control of noise pollution. Radiation pollution- radioisotopes, sources and effects.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Treatment of different industrial waste water distilleries, tanneries, dyeing industries. NAAQ Standards, Air Quality Index (AQI), Water auditing, wastewater irrigation, biochar for wastewater treatment.

REFERENCES:

1. De, A. K., Environmental Chemistry, Wiley Eastern Ltd., New Delhi, 1987.
2. Kannan, K., Fundamentals of Environmental Pollution, S. Chand and Co., Delhi, 1991.
3. Rao, M. N and Rao, H.V.N., Air Pollution, Tata McGraw HillPublishing Co. Ltd., New Delhi, 1989.
4. Sharma, B,K and Kaur, H., Soil and Noise Pollution, Goel Publishing House, Meerut,1994.
5. Sharma, B,K and Kaur, H., Water Pollution, Goyal Publishing House, Meerut,1994.
6. Brady, N.C. The nature and properties of Soils, Tenth Edition. Mac Millan Publishing Co., New York, 1990
7. https://www.crcpress.com/Soil-and-Water-Contamination-2ndEdition/Perk/p/book/9780415893435
8. https://www.ebooks.com/1683186/water-pollution-xii/brebbia-c-a/
9. https://www.ebooks.com/238584/water-quality-hazards-and-dispersion-of-pollutants/czernuszenko-wlodzimierz-rowinski-pawel/

COURSE OUTCOMES:

- To Learner gain knowledge in all types of pollution
- The paper gives clarity about the different sources of freshwater.
- The importance of pollution management is clearly explained.
- The learner could think about the uniqueness of water and the need for its conservation is made to be understood.
- The learner could plan a research work based on the syllabus for the betterment of the Air, soil and water quality.
- The treatment techniques available for drinking and waste water are made clear.
- The student could get employed in waste water treatment plants, industries, STP's, Pollution control boards or could promoted omesticor industrial waste water treatment by himself/herself.
- Thefinalunitisaself-studyunitwhichcouldmotivatethestudentandpaveswayforhim/hertounderstandfurtherdetailsregardingwastewatertreatment.

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Second Year | **CORE PRACTICAL III** | **Semester III**

AIR AND SOIL POLLUTION

Code | **(Practical)** | **Credit: 4**

LIST OF EXPERIMENTS:

I AIR ANALYSIS:

1. Estimation of PM_{10} in the ambient air
2. Demonstration of SO_2 in the ambient air
3. Demonstration NO_xin the ambient air
4. Measurement of Ambient noise level

II SOIL ANALYSIS:

1. Estimation of pH - pH metric method
2. Estimation of EC – Conductivity method
3. Estimation of Alkalinity
4. Estimation of Total Organic Matter
5. Estimation of Phosphorous
6. Estimation of Sodium and Potassium

REFERENCES:

1. Trivedy, R K., Goel, P. K and Trisal, L. Practical Methods in Ecology and Environmental Sciences. Environmental Publications, Karad, 1987.
2. Howard S.Peavy., Donald R. Rowe and George Tchobanoglous, Environmental Engineering. Indian Edition,2017
3. Sawyer, C. N. and McCarty, P. L. Chemistry for Environmental Engineering, McGraw Hill International, 1978.
4. Margesin R and Schinner. Manual of Soil Analysis – Monitoring and Assessing Bioremediation. Springer –Verlag Berlin Heidelberg, 2005.
5. James P. Lodge. Methods of Air Sampling and Analysis. Inter Society Committee Publication, 1988.
6. APHA. Standard Method for Examination of Water and Wastewater. APHA –AWWA – WPCF, 1989.
7. APHA. Standard Method for Examination of Water and Wastewater. APHA –AWWA – WEF, 1998.
8. http://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf
9. http://kspcb.gov.in/NAAQSManualVolumeI.pdf
10. https://www.youtube.com/watch?v=zXvEmlFqicw

COURSE OUTCOMES:

- Explain the collection, handling and preservation of the environmental samples
- Assess the PM10 in the ambient air
- Demonstrate SO_2 and NO_x in the ambient air
- Measure the ambient noise level
- Analyze the physico- chemical parameters of soil
- Compare the results with the standards.

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Second Year	**SECOND ALLIED COURSE I CHEMISTRY I**	**Semester III**
Code	**(Theory)**	**Credit: 4**

COURSE OBJECTIVES:

- To understand the various the ories of coord ination chemistry.
- To study the various concepts of resonance and halogen compounds.
- To study the properties of aromatic compounds and organic reactions.
- To learn the concepts of solid-state chemistry.

UNIT – I COORDINATIONCHEMISTRYANDINDUSTRIALCHEMISTRY:

1.1 Coordination Chemistry: Nomenclature–Werner's, sidgwick and Pauling's the ories. Chelation-industrial importance of EDTA, Biological role of hemoglobin and Chrophyll.

1.2 Industrial Chemistry: Fuelgases – Watergas, producer gas, LPG gas, Gobar gas and natural gas. Fertilizers – NPK and mixed Fertilizers- soaps and detergents.

UNIT –II ELECTRON DISPLACEMENT EFFECTS AND HALOGEN COMPOUNDS:

2.1 Polareffects: Inductive effect –Relative Strength of Aliphatic monocarboxylic acid and aliphatic amines. Resonance–Condition for resonance. Consequences of resonance – resonance of energy. Basic property of aniline and acidic property of phenol. Hyper conjugation – Heat of hydrogenation – Bond length and dipole moment. Steric effect.

2.2 Halogen containing compounds: Important chloro-hydrocarbons use dassolvents. Pesticides–Dichloromethane, chloroform, carbon tetrachloride, DDT and BHC Types of solvents:-Polar, Non-polar.

UNIT – III AROMATIC COMPOUNDS AND ORGANIC REACTIONS:

3.1 Aromatic compounds: Structure, stability resonance and aromaticity of benzene. Substitution reaction: Nitration, Halogenations, Alkylation. Naphthalene – Isolation, properties and uses.

3.2 Organic reaction: Biuret, Decarboxylation, Benzoin, Perkin, Cannizaro, Claisen and Halo form reactions

3.3 Chemotherapy: Explanation with two examples each for analgesics, antibacterial, anti - inflammatory, antibiotics, antiseptic and disinfectant, anesthetics local and general (Structures not necessary).

UNIT – IV SOLIDSTATE, ENERGETICS AND PHASERULE:

4.1 Solidstate: Typical crystal lattices - unit cell, elements of symmetry, Bragg's equation, Weiss Indices, Miller indices, simple body centered and face centered lattices

4.2 Energetics: First law of thermodynamics – state and path function – need for the second law – carnotscycle and thermo- dynamic scale of temperature, spontaneous and Non–spontaneous processes–entropy – Gibbs free energy.

4.3 Phase rule: Phase, component, degree of Freedom, phase rule definitions – one component system–water system.

UNIT – V CHEMICALEQUILIBRIUMANDCHEMICALKINETICS:

5.1 Chemical equilibrium: Criteria of homo generous and heterogeneous equilibria, - decomposition of HI, N_2O_4, $CaCO_3$+Pd5.

5.2 Chemical Kinetics: Order of reaction and their determinations-activation energy, effects of temperature on reaction rate.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Assignments and seminar on industrial applications of coordination compounds, describing thermodynamic conditions for Haber and contact process, Arrhenius theory for rate constant of a reaction, Thermodynamic conditions for spontaneous and non-spontaneous processes, mode of action of antibiotic, analgesics and anti-inflammatory drugs.

REFERENCES:

1. Gopalan R, Text Book of Inorganic Chemistry, 2nd Edition, Hyderabad, Universities Press, (India), 2012.
2. Morrison R.T. and Boyd R.N., Bhattacharjee S.K. Organic Chemistry (7th edition), Pearson India, (2011).
3. Puri B.R., Sharma L.R. and Pathania M.S. (2013), Principles of Physical Chemistry, (35thedition), New Delhi: Shoban Lal Nagin Chandand Co.
4. https://gascnagercoil.in/wp-content/uploads/2020/12/allied-chemistry-book.pdf

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

1. To describe structure and functions of biologically important coordination compounds.
2. To apply eletromeric and resonance effect to predict reactivity and stability of organic compounds
3. To cclassify the drugs based on their mode of actions.
4. To predict conditions for spontaneous and non-spontaneous reactions.
5. To calculate Gibb's free energy, work function and entropy of a reaction
6. To determine order of chemical reactions

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Second Year **SECOND ALLIED PRACTICAL I VOLUMETRIC AND ORGANIC QUALITATIVE ANALYSIS** **Semester III**

Code **(Practical)** **Credit: 2**

COURSE OBJECTIVES:

- To learn the techniques of titrimetric analyses.
- To know the estimation of several cations and anions.
- To learn the techniques of qualitative analysis of organic compounds

I Volumetric Analysis:

1. Acidimetry and alkalimetry:

(a) Strongacid VS strongbase (b) Weakacid VS strongbase (c) Determination of hardness of water.

2. Permanganometry:

(a) Estimation off erroussulphate (b) Estimation of oxalic acid

3. Iodometry:

(a) Estimation of potassium dichromate (b) Estimation of potassium permanganate

II. Organic Analysis:

Analyse the following organic Compounds.

1. Carbohydrate, 2. Amide, 3. Aldehyde, 4. Ketone, 5. Acid & 6. Amine.

The students may be trained to perform the specific reactions like tests for aliphatic or aromatic, saturated or unsaturated and functional group present and record their observations.

REFERENCES:

1. R.Gopalan, Elements of analytical chemistry, S.Chand, New Delhi, 2000.
2. N.S.Gnanapragasam and G.Ramamurthy, Organic Chemistry lab manual, S.Viswanathan and Co. Pvt. Ltd. Chennai-1998

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

1. To understand the use of volumetric pipette, burette and analytical balance.
2. To explain the principles of volumetric analysis,

3. To prepare standard solution to find out the concentrations of unknown analyte,
4. To understand the selection of indicators and can apply the knowledge in chemical experiments.
5. To understand the fundamental methods and procedures adopted in organic analysis.
6. To perform systematic qualitative organic analysis of common organic compounds.

Note: Scheme for Practical Evaluation.

Organic Qualitative Analysis:	- 20
Volumetric Estimation:	- 35
Record:	- 05
Internal Assessment:	- 40
Total:	**-100**

Volumetric Analysis: - 35

Procedure 5 marks Results

<2%	-30marks
2-3%	-20marks
3-4%	-10marks
>4%	-05marks

Organic Qualitative Analysis: - 20

Saturated and unsaturated	- 4marks
Aliphatic or Aromatic	- 4marks
Preliminary reactions with Procedure	- 6marks
Functional group identified Correctly	- 6marks
Total:	**- 20 marks**

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Second Year	CORE COURSE IV	Semester IV
	NATURAL RESOURCES	
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

- To have a basic knowledge of Natural resources its classification, concepts and natural resources of India.
- This course explains about the natural resources which influences quality of life, and the functioning of natural environment.
- The course is designed to understand the importance of resources in the nature.

UNIT - I:

WATER RESOURCES: Characteristics of Water Bodies, Utility of Surface and Ground Water, Fresh Water and Marine Water Resources. Water Storage Systems and their Importance. Watershed Management - Aquifers, Rain Water Harvesting System.

UNIT - II:

LAND RESOURCES: Introduction to Land Resources and their Types. Land Degradation and Soil Erosion - Causes and Impacts - Desertification, Deforestation, Mineral Resources: Minerals on the Geosphere, Types of Minerals, Mining - Metal and Non - Metal Resources, Exploitation of Mineral Resources, Use of Mineral Resources.

UNIT - III:

BIOLOGICAL RESOURCES: Forest Types and their Resources, Carbon Sequestration, Use and Over-Exploitation – Timber and their Resources, Effects on Forest and Tribal People – Social and Cultural Forest. Agricultural resources and practices, Green revolution, White revolution and Blue revolution. Livestock Resource.

UNIT - IV:

NON – RENEWABLE ENERGY RESOURCES: Fundamentals of energy and measurements: Types – fossil fuels :coal, oil, natural gas,– Non-fossil fuels: nuclear energy, Indian Energy Scenario

UNIT - V:

RENEWABLE ENERGY SOURCES: Sources and applications of Solar, Wind, Biomass, Hydropower, Tidal, waves and Ocean thermal energy conversion system, Geothermal energy and gas hydrates. Bio hydrogen as a source of energy.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Biomass conversion technologies – energy from waste – Briquetting – Pedal power devices – Urjagram – Energy Villages

REFERENCES:

1. Ecology of Natural Resources, Ferancois Ramade (1991), John Wiley.
2. Text book of Environmental Studies, Eranch Bharucha (2005), Universities Press.
3. Environmental Studies, Kumarasamy K, Alagappa Moses A and Vasanthy M (2004), Bharathidasan University Publishers.
4. Environmental Science and Technology, Stanley E. Manahan (2007), Taylor & Francis, CRC Press.
5. Instant notes Ecology, Aulay Mackenzie, Andy S.Ball and Sonia R.Virdee (2002), Bios Scientific Pub. Ltd.,
6. Environmental Science, Physical Principals and Application, Egbert Boeker and rienk van Gondelle (2001), John Wiley & Sons.
7. Environmental Science, Santra, S.C (2005), New Central Book Agency (P) Ltd.,
8. Forest Economics and Management, Sharma, L.C (1998), M/S Bishen Singh Mahendrapal Singh, Dehradun.
9. G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
10. R.K. Rajput, Non Conventional Energy Sources and Utilisation, S.Chand& Company Ltd., 2012.
11. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFNSpon Ltd., 1986.
12. B.H.Khan, Non-Conventional Energy Resources, Tata McGraw Hill, 2nd Edn, 2009.
13. Bent Sørensen, Renewable Energy Conversion, Transmission and Storage, Elsevier Inc, 2007.
14. Demirel and Yaşar, Energy-Production, Conversion, Storage, Conservation, and Coupling, Springer Link, 2012.

COURSE OUTCOMES:

- The course content in traduces the concept to foreknowable and non-renewable energy resources and its scenario in India and at global level
- The course explains the other recourses (Water, Land and Biological) of energy.
- TheenergyusagepatternoftheworldandIndiawashighlightedinaplannedmanner
- The student would under stand the importance of energy resources in a systematic way.

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Second Year	**CORE PRACTICAL IV WATER POLLUTION**	**Semester IV**
Code	**(Practical)**	**Credit: 5**

COURSE OBJECTIVES:

LIST OF EXPERIMENTS:

1. Estimation of pH - metric method **(4 Hrs.)**
2. Estimation of EC – Conductivity method **(4 Hrs.)**
3. Estimation of Turbidity -Nephelometric method **(4 Hrs.)**
4. Estimation of Total Dissolved Solids (TDS)-Gravimetric and Filtration method **(4 Hrs.)**
5. Estimation of Dissolved Oxygen- (DO) - Winkler's method **(4 Hrs.)**
6. Estimation of Total Hardness **(4 Hrs.)**
7. Estimation of Chloride **(4 Hrs.)**
8. Estimation of Phosphorous **(4 Hrs.)**
9. Estimation of Nitrite **(4 Hrs.)**
10. Estimation of Nitrate **(4 Hrs.)**
11. Identification of Pollution Indicators – (Plants, Planktons and Microbes) **(20 Hrs.)**

REFERENCES:

1. Trivedy, R. K and Goel, P. K. Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad,1984.
2. Sawyer, C.N. and McCarty,P. Chemistry for Environmental Engineering. Mc Graw Hill International, 1978.
3. APHA. Standard Method for Examination of Water and Waste water. APHA – AWWA – WEF, 1998.
4. APHA. Standard Method for Examination of Water and Waste water. APHA – AWWA – WPCF, 1989.
5. https://www.who.int/water_sanitation_health/resourcesquality/wqmchap6.pdf
6. http://web.iitd.ac.in/~arunku/files/CEL212_2012/Lab%206%20Dissolved%20Oxygen.pdf
7. https://www.tandfonline.com/doi/pdf/10.1080/21553769.2016.1162753

COURSE OUTCOMES:

- List the water pollution problems
- Analyze the water samples with the various physico-chemical parameters
- Label the water samples from the various sources
- Compare the results with the standards
- Identify the pollution indicators
- Recommend preventive and alternate practices to reduce pollution.

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Second Year	**SECOND ALLIED COURSE II CHEMISTRY II**	**Semester IV**
Code	**(Theory)**	**Credit: 4**

COURSE OBJECTIVES:

- To learn the basics of nuclear chemistry and metallic bond**.**
- To understand the properties and applications of carbohydrates, amino acids and proteins.
- To study the basic concepts of polymers, heterocyclic compounds and stereoisomerism.

UNIT – I NUCLEARCHEMISTRYANDMETALLICBOND:

1.1 Nuclear Chemistry: Fundamental particles of nucleus- isotopes, isobars, isotones and isomers – differences between chemical reactions and nuclear reactions, nuclear fusion and fission-radioactive series.
1.2 Metallic bond: Electron gas, Pauling and band theories, semiconductors – intrinsic, extrinsic – type and p – type semico nductors.
1.3 Compounds of sulphur and sodiumthiosulphate

UNIT – II CARBOHYDRATES, AMINO ACIDS AND PROTEINS:

2.1 Carbohydrates: classification –glucose and fructose–preparation and properties – structure of glucose –Fischer and Haworth cyclic structures.
2.2 Amino acids and proteins: Amino acids – Classification based on structure. Essential and non – essentials amino acids – preparation, properties and uses – peptides (elementary treatment only) – proteins – Classification based on physical properties and biological functions. Structure of proteins–primary and secondary (elementary treatment).

UNIT – III POLYMERS, HETEROCYCLIC COMPOUND AND STEREOISOMERISM:

3.1 Synthetic polymers: preparation, properties and uses of Teflon, epoxy resins, polyester resin.
3.2 Heterocyclic compounds: Furan, pyrrole and pyridine –preparation, properties and uses – basic properties of pyridine and pyrrole.
3.3 Stereoisomerism: Optical isomerism – Lactic and tartaric acid – racemic mixture and resolution. Geometrical isomerism–maleic and fumaricacids.

Unit – IV Surface and photochemistry:

4.1 Surface Chemistry: Emulsions, gels–preparation, properties - Electrophoresis and applications, chromatography – Column, paper and thin layer Chromatography.

4.2 Photochemistry: Laws of photochemistry and applications.

Unit – V ELECTROCHEMISTRY, pH AND BUFFER

5.1 Electrochemistry: Specific and equivalent conductivity–their determination – effect of dilution on conductivity. Ostwald's Dilution law, Kohlrausch law, conductivity measurements, and conduct metric titrations.

5.2 pH and buffer: Importance of Ph and buffers –pH determination by colorimetric and electrometric methods.

UNIT – VI CURRENT CONTOURS (FOR CONTINUOUS INTERNAL ASSESSMENT ONLY):

Assignments and seminar on nuclear radiation, nuclear reactors, structure of carbohydrates and proteins, aromaticity of heterocyclic compounds. Hands on training to determine dissociation constant of acetic acid using conduct meter and to determination of pH of acetic acid sodium acetate buffer by conductivity measurements.

REFERENCES:

1. B.R. Puri, L.R. Sharma, K.C. Kalia, 'Principles of Inorganic Chemistry', 21st edition, Vallabh Publications, 2004-2005.
2. Bahl, B.S. and Bahl, A., Organic Chemistry, (12thedition), New Delhi, Sultan Chand & Co., (2010).
3. Puri B.R., Sharma L.R. and Pathania M.S. (2013), Principles of Physical Chemistry, (35th edition), New Delhi: Shoban Lal Nagin Chand and Co.
4. https://oms.bdu.ac.in/ec/browse.php?type=UG

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- To explain theory of nuclear chemistry and chemical bonding.
- To classify carbohydrates and proteins.
- To synthesise polymers and hetero cyclic compounds.
- To apply conductivity measurements to determine degree of dissociation of weak electrolyte and pH of buffer solution.
- To explain preparation and applications of emulsion and gels in chromatography.

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Third Year **CORE COURSE V** **Semester V**

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To understand the harmful and useful microbes in the Environment.
- To apply the Microbial Biotechnology as a tool for Bioremediation.
- To learn about the interaction of microbes with the environment.

UNIT - I:

History and scope of microbiology – Ultra structure of Prokaryotic and Eukaryotic cells, general structure and nutritional classification of bacteria, virus, fungi, yeast and algae, Growth and reproduction of bacteria and fungi.

UNIT - II:

Distribution of microorganisms in soil - Factors influencing the soil microflora – Role of microorganisms in soil fertility - Interactions among microorganisms: Mutualisms, commensalism, competition, amensalism, parasitism, predation - Interactions between microbes and plants: Rhizosphere, phyllosphere, mycorrhizae. Microbes in Biogeochemical cycles: Carbon cycle - Role of microbes in Carbon cycle - Nitrogen cycle - Mechanism of biological nitrogen fixation - Ammonification, Nitrification, Denitrification – Role of microbes in Phosphorous cycle

UNIT – III:

Microbial air pollutants – Bioaerosols, Aero allergens - Airbone diseases, Symptoms and preventive measures – Microbes involved in waterborne diseases - Assessment of microbiological quality of water - MPN technique and Biological Oxygen Demand.

UNIT – IV:

Enzymes used in recombinant DNA technology. Steps involved in rDNA technology, Genomic and cDNA libraries. Cloning and expression vectors - plasmids, bacteriophage, phagmids, cosmids. Molecular tools and methods – Electrophoresis and PCR.

UNIT – V:

Ecological Restoration: Wastewater treatment: Anaerobic and aerobic process, Methanogenesis, Bioreactors. immobilization techniques - Bioremediation: Biostimulation and Bioaugmentation, Phytoremediation. Biofertilizers – Biopesticides – Biofuels – Biomining. Genetically Modified organisms - merits and demerits.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Environmental Genomics and Microbial Ecology; Genetic Exchange Gene Transfer: Replication, Transformation Transduction Molecular Biology Tools: Cloning, Amplification, Sequencing, with a Case Study

REFERENCE BOOKS:

1. Atlas, R. M. and Bartha, R., Microbial Ecology – Fundamentals and Applications, Benjamin/Cummings Science Publishing, 1998.
2. Baker, K. H. and Herson, D. S.,
3. Bioremediation, McGraw-Hill Inc., 1994. Bitton, G., Wastewater Microbiology, Wiley-Liss Inc., 1994.
4. Mitchel, R., (ed.) Environmental Microbiology, Wiley-Liss Inc., 1992.
5. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R., Microbiology – Concepts andApplications, McGraw-Hill Book Co., 1993.
6. Murugesan, A.G. and Rajakumari, C., Environmental Science and Biotechnology, MJP Publishers, Chennai, 2006.
7. Scrogg, A., Environmental Biotechnology, Second edition, Oxford University Press, New York, 2005.
8. Gupta, P.K., Elements of Biotechnology, Rastogi Publications, Meerut, 2007.
9. Abbasi, S.A. and Ramasami, E., Biotechnological Methods of Pollution Control, University Press, Hyderabad, 1999.
10. Gupta, H.C.L., Siddiqui, A.U. and Parihar, A., Biopest Management (Entomopathogenic Nematodes, Microbes & Bioagents), Agrotech Publishing Academy, Udaipur, 2010.
11. Somani, L.L., Shilpkar, P. And Shilpkar, D., Biofertilizers – Commercial Production Technology & Quality Control, Agrotech Publishing Academy, Udaipur, 2011.
12. Jemba, P.K., Environmental Microbiology, Science Publishers, New Hampshire, 2004.
13. Srivastava, M.L., Basic Environmental Microbiology, Manohar Books, New Delhi, 2003.
14. Raina, M., Pepper, I. and Gerba, C., Environmental Microbiology, Academic Press, New York, 2006.

COURSE OUTCOMES:

- The basics of Microbiology such as the types of micro besand their classification is taught
- The identification of microbes using the basic and advanced to olsis exposed to the students
- The metabolism involved in the microbial system is explained
- There mediation of pollutants by microbes is emphasized
- To describe suitable methods for characterizing the activity, function, diversity and composition of microbial communities
- To elucidate the microbial processes and growth requirement sun delaying different treatment techniques.
- To evaluate the potential for biodegradation of organic and inorganic pollutants, taking microbial and physical / chemical environments, as well as the chemical structure of the compound itself, into consideration.

Third Year **CORE COURSE VI** **Semester V**

ENVIRONMENTAL SANITATION

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

To learn sanitary and hygienic aspects in the context of a number of social institutions and processes.

UNIT - I:

Epidemiology – Principles of protecting the environmental sanitation measures, Inspect and Rodent Control, community sanitation measures – sanitation of camps, festivals, schools, swimming pools etc.

UNIT - II:

Food and milk sanitation, hotel management with reference to sanitation – food preservation, pasteurization methods and plants. Housing need – lighting and ventilation, natural and artificial provisions.

UNIT – III:

Solid wastes – characteristics, collection, disposal by landfill, composting, incineration and other methods. Handling and disposal of Hazardous Wastes. Industrial Hygiene– Occupational hazards – Various operations in industrial units, Engineering and safety measures. Radiological health – radioactive wastes and disposal.

UNIT – IV:

Noise Pollution and control – Engineering and medical divisions – various programmes. Rural sanitation various methods of collection and disposal of fecal matter – community toilets – septic tanks and soak pits – biogas plants.

UNIT – V:

Public Health – Occupational hazards, Industrial hygiene, Rural Water Supply and sanitation, biogas – community toilets.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Excreta management systems, Transmission of Diseases, Environmental Health, Sanitation PPT

REFERENCES:

1. Municipal and Rural Sanitation (Sanitary Science & Water Engineering) by V. M. Ehlers, Ernest W. Steel- Tata Mcgraw-hill Education (1977)
2. Environmental Sanitation by Joseph A. Salvato – John Wiley & Sons Inc
3. Environmental Protection by Emil T. Chanlett – Mcgraw –hillI nc., us

COURSE OUTCOMES:

- An outlook on epidemiological concept vis-a-vis various sanitary measures.
- Knowledge on sanitary aspects in relation to different social institutions.

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Third Year **CORE COURSE VII** **Semester V**

SUSTAINABLE DEVELOPMENT

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To understand the concepts of sustainable development.
- To know the global issues and initiatives taken for sustainable development.
- To train students to undertake major initiatives in the efficient management of natural resources and the prevention of environmental pollution with focus on Sustainable Development

UNIT - I:

Sustainable Development: Definitions and Goals, global energy policies and resources; Green movements; Green and Eco philosophy; Ecological-footprints; corporate response to sustainable development - Brundtland Commission; Human Development Index; Living Plant Index

UNIT - II:

National policy statement of environment and development; National Environment Policy 2006: an overview; Legislative framework of environmental protection, historical perspectives and Indian constitutional provisions. Environmental Impact Assessment, Environmental Audit, Urban and Rural planning. Remote sensing and GIS applications.

UNIT - III:

Environmental Acts and rules - Water (Prevention and control of Pollution Act, 1974), Air (Prevention and control of Pollution Act, 1981), Environment (protection) Act 1986, International treaties on Environmental protection: Ramsar Convention, Montreal protocol, Kyoto protocol, Convention on International trade of endangered species.

UNIT - IV:

Protected Area, Current Practices in Conservation - In Situ Conservation and Ex Situ Conservation of Threatened Species - Cryopreservation, Gene Banks, Gene Pool and Species Conservation. National Parks and Sanctuaries. Common Flora and Fauna in India, The Biological Diversity Act, 2002, Agenda 21, Multilateral Treaties, Biodiversity Conventions. Patent Act - Intellectual Property Rights (IPR).

UNIT - V:

Concepts, Principles and Characters of Environmental Education; Importance and history of Environmental Education; Global (UNEP, WII, CSE, IPCC, IUCN) and National (WWF- I, CPR Environmental Education Centre, Centre for Environmental Education) Environmental organizations – objectives and activities, Major Environmental Activism Movements – Bishnoi, Chipko& Silent Valley. Environmental Ethics.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Globalization and Economic growth. Economic development: Economic inequalities, Income and growth, Millennium Development Goals, International climate change agreements – UNFCCC, The Kyoto Protocol

REFERENCES:

1. The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R., New Society Publishers, 2005.
2. Sustainable development in India: Stocktaking in the run up to
3. Rio+20: Report prepared by TERI for MoEF, 2011.
4. Report of the Department for Policy Coordination and Sustainable
5. Development (DPCSD), United Nations Division for Sustainable
6. Development Corporate Social Responsibility Part I, Part II, Part III by David Crowther and Guler Aras
7. Nick Hanley, Jainson F. Shorgen and Ben White, Environmental Economics – In Theory and Practice, Macmillan India Ltd, New Delhi,1999.
8. Roger Perman, Yue Ma and James McGilvray, Natural Resources and Environmental Economics, II Edition, Addison Weley Longman Ltd, Singapore,1997.
9. John Bowers, Sustainability and Environmental Economics, Addison Weley Longman Ltd, Singapore, 1997.
10. David W. Pearce and Kerry R Turner, Economics of Natural Resources and The Environment, The Johns Hopkins University Press, Baltimore,1999.
11. Uberoi, N. K, Environmental Management, Excel Book, New Delhi, 2004.
12. Kerry R. Turner, David W. Pearce and Ian Bateman, Environmental Economics – An Elementary Introduction, The Johns Hopkins University Press, Baltimore, 1993.

COURSE OUTCOMES:

- The course is thus designed to fill up these gaps by imparting the knowledge in the field of Sustainable Development and Environment Management to those interested to make their rewarding career in this field.
- To empower students and make them capable of applying what has been learned in a wider context of development aspects
- The course will equip the students with economic methods and tools to analyze and value environmental goods and services.
- The course will also provide insights into some of the approaches to address energy related environmental problems and also on the options available to policy makers to cope with issues of global warming and climate change for a sustainable world
- The student will understand the differences between economic and social development as well as the different development needs across the life span.

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Third Year	**CORE PRACTICAL V**	**Semester V**
	ENVIRONMENTAL MICROBILOGY	
Code	**(Practical)**	**Credit: 4**

1. Introduction to General Microbiology: Laboratory Rules, Microscopy, Sterilization, Preparation of Culture Media, Isolation of Bacteria from Soil, Isolation of fungi from Soil, Ubiquitous nature of Microorganisms.
2. Types of staining techniques: Simple staining, Gram staining, Capsular staining and Endospore staining.
3. Demonstration of motility for bacteria by hanging drop technique
4. List of Biochemical Test: Indole production, Methyl Red, Voges Proskaeur, Citrate Utilization, Triple sugar-Iron agar, Catalase and Oxidase Test
5. Antibiotic sensitivity test: Disc diffusion method
6. Most Probable Number (MPN): Presumptive, Confirmatory and complete test
7. Identification of Fungi: Lacto phenol cotton blue test

REFERENCES:

Willey. Prescott's Microbiology. New York: McGraw-Hill, 2011.

COURSE OUTCOMES:

- The students are introduced to the diversity of microbial populations in the environment
- The practical provides knowledge to the students to learn the role of microbes in the environmental processes
- The role of microbial activities in sustaining the natural ecosystem and environmental quality is also understood from the practical
- Characterizing microorganisms and investigating microbial processes is taught to the student
- One can know various culture medias and their applications and also understand various physical and chemical means of sterilization
- Microbial techniques for isolation of pure cultures of bacteria, fungi is explained
- The student will be able to perform routine culture handling tasks safely and effectively
- The learner will be able to identify the bacteria and fungi by employing molecular techniques too.

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Third Year **MAJOR BASED ELECTIVE I** **Semester V**

1) CLIMATE CHANGE AND ITS IMPACT

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To understand the structure and composition of the Earth.
- To describe the climatology pattern, changes and its effect on earth.
- To discuss the climate change impact and its mitigation.

UNIT – I:

Overview of the structure and composition of the atmosphere; earth and sun relations - rotation, revolution and seasons. Atmosphere, Hydrosphere, Lithosphere, Biosphere and their linkage, Earth's geological history and development and evolution of the atmosphere; Gaina Hypothesis. Element of climate, climate controls.

UNIT – II:

Meteorology fundamental – Energy, radiation, temperature and heat; pressure, pressure belts, wind and atmospheric circulation; atmospheric moisture humidity, condensation, formation of precipitation, dew, fog and clouds; atmospheric stability, adiabatic process; scales of meteorology; urban areas; atmospheric stability diagrams, turbulences, diffusion. Wind roses,

UNIT – III:

Atmosphere and climate. Basic atmosphere properties, climate controls. Climate classifications and variability. Atmospheric climate - global scale, regional scale, locals scale. Oceans: General circulation patterns. Air-Sea interaction. Tropical systems– equatorial trough, ITCZ, jet streams, vortices; Indian monsoon.

UNIT – IV:

Global Energy balance: Source, transfer, distribution. Energy balance of the atmosphere. Wind, stability and turbulence; El Niño, southern oscillations cyclones. Natural climate changes: Records of climate change (glacial cycles, ocean sediments, corals, tree rings). Climatic considerations in industrial locations and city planning. Oceans and variation in climate.

UNIT – V:

Human impact on climate-causes and consequences of Global warming – Global and regional trends in greenhouse gas emissions –Sea level rise; role of oceans and forests as carbon sinks, Ozone hole. Montreal protocol; Kyoto Protocol; carbon trading. Physiography, spatial and temporal patterns of climatic parameters - temperature, rainfall and its variability in India with special reference to NE monsoon, general circulation.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Impacts of climate changes- Effects on organisms including humans; effects on disease; Extinction risk for temperature –sensitive species; UV effects, CO_2 Deposition at global level

REFERENCES:

1. Barry RG, (2003). Atmosphere, weather and climate. Routledge Press, UK
2. Burrough WS, (2007). Climate change; A multidisciplinary Approach, CUP
3. Critchfield Howard J, (1998). General climatology, prentice Hall India Pvt. Ltd., New Delhi.
4. Critichfield HJ, (2002). General Climatology, PHI.
5. Das Monsoon PK, NBT 17.
6. David D Houghton, (2002). Introduction to climate change: Lecture notes for meteorologist, World Meteorologist Organization.
7. Donald Ahrens C. Meteorology Today – An introduction to weather, climate and the environment Brooks/Cole Thompson Learning.
8. Firor J and Jacobsen JE, (2002). The crowded green house: population, climate changes and creating a sustainable world. Yale University press.
9. Gorden, (1998). Dynamic Meteorology - A basic course, Arnold,
10. Harvery D, (2000). Climate and Global climate changes. Premtioce Hall.
11. Menon, P.A. Our Weather, NBT.
12. Natalia Trofimenko, (2011). Climate change: current issues
13. Oliver J.E. and Hidore J.J. Climatology and atmospheric science.
14. http://nca2014.globalchange.gov .
15. http://rhg.com/wpcontent/uploads/2014/06/RHG_AmericanClimateProspectus_June2014_LowRes1.pdf.
16. http://www.unc.edu/~jjwest/ClimateCourse-Syllabus_2015.pdf
17. www.hmmtreasury.gov.uk/independent_reviews/stern_review_economics_climate _ change/ stern review_report.cfm.
18. www.aip.org/history/climate.
19. www.realclimate.org.
20. www.globalchange.gov/engage/process-products/sap-summary

COURSE OUTCOMES:

- The learner could understand the climate variables
- The student would obtain the knowledge about climate change and seasonal changes
- The student could learn about the factors influencing climate change and impacts on environment and health
- One can understand about the significance of global warming on human life, agriculture etc
- The learner will obtain knowledge about the inter-relation between greenhouse gases, global warming and climate change.

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Third Year **MAJOR BASED ELECTIVE I** **Semester V**

2) GLOBAL WARMING AND ISSUES

Code **(Theory)** **Credit: 4**

COURCE OBJECTIVES:

- This course introduces the main aspects of climate and how it is altered due to various anthropogenic activities. It also covers the Science of climate changes and risks it causes.
- The students will also learn about the potential impact on society economy and environment due to climate change and the action plan involved in its mitigations.

UNIT – I:

Climate -Past and present, Development of climatology, its scope and its contemporary relevance Structure and Composition of the atmosphere Elements of Climate: Insolation, Temperature, Moisture, Pressure Systems; Wind systems and General Circulation of the atmosphere.

UNIT – II:

Global Temperature, Influence of Green House Gases on Global Warming, Inter governmental Panel on Climate Change (IPCC), Projections for Future Climate Change. Modeling Global Climate Change-Extreme Climate Events and Vulnerability.

UNIT – III:

Definition of Climate Change – Causes and Impacts of Climate Change (Green House Gases (Sources, Effects). Role of Oceans and Carbon Sinks, Stratospheric Ozone Shield and Ozone depletion. Effect of Climate Change on Weather and Climatic Patterns, Melting Ice Caps, Sea Rise.

UNIT – IV:

Importance of Climate Mitigation, Strategies – Renewable Energy, Green Building, Energy Efficiency, Reducing Consumption, Low Carbon Development Sectors with High Mitigation Potential.EmissionTrading and Carbon Credits. Creation of awareness.

UNIT - V:

National – Urban, Local Bodies, Panchayats. International ActionPlan, Policies, Protocols and Agreements. Role of UN Collaborative Programme on Reducing Emissions from Vehicles - United Nation Framework Convention on Climate Change (UNFCCC), The Kyoto Protocol. Montreal Protocol.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Group discussion on raising temperature and impact on public health. A visit to Indian Metrological Department, Chennai. Discussion onweather forecasting, Brain storming session on global warming insociety.

REFERENCES:

1. ClimateChangeandBiodiversity:PerspectivesandMitigationStrategies - Prabha Shastri Ranade, (2008), ICFAI University Press, M.Sc. Environmental Sciences-UD-2017-18 onwards Annexure No:73A Page 36 of 43 SCAA Dated: 03.07.2017
2. Environmental Science: Earthasa Living Planet. Botkin, Daniel B. and Keller, Edward A.,(2007),6thed.John Wiley & Sons, USA.
3. Climate Change: A Multi-disciplinary Approach. Burroughs, W.J. (2007), 2nd ed. Cambridge UniversityPress.2007.
4. The Global Environment in the Twenty-First Century-Prospects for International Co-operation. Chasek, P. S. (2004), Indian Reprint by Manas Publications, New Delhi.
5. Climate Change: Scenario, Strategies and Solutions. Claussen, E.ed. (2001), Arlington VA.
6. Climate Change-An Indian Perspective. Dash, S. K. (2007), Centre for Environment Education and Cambridge University Press Pvt. Ltd., New Delhi.
7. Earth Summit. Dodds, F.(ed.). (2002), A New Deal. Earth scan Publications Ltd., UK.
8. Environmental Science: A Study of Interrelationships. Enger, E.D. and Smith, B. F. (2006), 11th ed. McGraw Hill Inc., USA.2006.
9. Climate Change: Causes, Effects, Solutions. Hardy, John T.(2003), Wiley & Sons, USA.
10. Global Environmental Issues. Harris, F.(2004),Wiley & Sons,Inc.,USA.
11. Global Warming: The Hard Science. Harvey L.D.D. (2000), NY: Prentice-Hall. IPCC, Emission Scenarios, Inter Governmental Panelon Climate Change, Cambridge University Press, 2000.
12. One Earth one Future:-Our Changing Global Environment, Silver C.S. and De Fries, R.S.(1991), East-West Press Edition.
13. Global Environmental Challenges–Transitions to a Sustainable World. Speth, J. C. (2004), Orient Longman Pvt. Ltd., New Delhi. UNEP.
14. climate.nasa,gov/
15. www.ucsua.org/
16. www.ccsi.org/
17. www.climate.gov/
18. www.renewablenology.world.com

COURSE OUTCOMES:

- The learner could understand the climate variables
- The student would obtain the knowledge about climate change and seasonal changes
- The student could learn about the factors influencing climate change
- One can understand about the significance of global warming on human life, agricultureetc
- The learner will obtain knowledge about the inter-relation between greenhouse gases, global warming and climate change.

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Third Year **SKILL BASED ELECTIVE I** **Semester V**

ENVIRONMENTAL EDUCATION AND AWARENESS

Code **(Theory)** **Credit: 2**

UNIT - I:

Basics of Environmental Education: Concepts, Principles and Characters of Environmental Education; Importance and history of Environmental Education; Global (UNEP, WII, CSE, IPCC, IUCN) and National (WWF- I, CPR Environmental Education Centre, Centre for Environmental Education, BVIEER) Environmental organizations – objectives and activities, Major Environmental Activism Movements – Bishnoi, Chipko and Silent Valley.

UNIT – II:

Methodology of Environmental Education: Forms of Environmental Education – Formal, non-formal; Guidelines of contents for early childhood, higher education, adult and general public; Current practices in India.

UNIT – III:

Environmental Awareness: Practice: Planning, preparation, Implementation and Evaluation of Environmental Awareness for rural school children

UNIT – IV:

Environmental Awareness for Urban Community: Practice: Planning, preparation, Implementation and Evaluation of Environmental Awareness for urban school / college community

UNIT - V

Environmental Awareness for General Public: Practice: Planning, preparation, Implementation and Evaluation of Environmental Awareness for general public

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Environmental Impacts, EIA, MoEF & CC Acts, EPA, Climate Change, Environment Management and Mitigation of Environmental issues

REFERENCES:

1. UNEP. Public Environmental Awareness and Education,2007
2. MOEF. National Environment Awareness Campaign.2011-2012Ministry of Environment & Forests. Government of India Paryavaran Bhawan CGO Complex Lodhi Road, New Delhi, 110003.
3. Early Childhood Environmental Education Programs: Guidelines for Excellence, North American Association for Environmental Education, 2000, USA, www.naaee.org www.eelink.net.
4. Joyce Meredith. A Project of Ohio. EE 2000: A Strategic Plan for

Environmental Education in Ohio. Published by: Environmental Education Council of Ohio P.O. Box 2911 Akron, OH 44309-2911,2000.
5. Non-formal Environmental Education Programs: Guidelines for Excellence. North American Association for Environmental Education. 2000 P Street, NW - Suite 540 Washington, DC 20036, USA.
6. http://envfor.nic.in/division/environmental-education-awareness-and-training-eeat
7. http://www.moef.nic.in/sites/default/files/chap5_0.pdf
8. http://www.yourarticlelibrary.com/environment/environmental-education-objectives-aims-and-principles-of-environmental-education/39724/
9. http://www.yourarticlelibrary.com/environment/organizing-environmental-education-system-formal-and-non-formal-education/28153/
10. http://www.yourarticlelibrary.com/essay/environment-essay/how-environmental-awareness-can-be-achieved/39725/
11. http://www.yourarticlelibrary.com/speech/importance-of-public-awareness-for-conservation-of-environment-in-india/30187/
12. http://www.unep.org/dec/onlinemanual/Enforcement/InstitutionalFrameworks/PublicAwarenessEducation/tabid/99/Default.aspx?page

COURSE OUTCOMES:

- Recall The history of environmental education
- List and analyze the different environmental organizations
- Summarize the concept of environmental education
- Categorize the different forms of education
- Plan and design the environmental education programs for various target groups
- Execute and review the environmental education programs for various target groups.

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Third Year	CORE COURSE VIII WASTE MANAGEMENT	Semester VI
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

- To provide information about various types wastes and waste characteristics.
- To introduce about the waste management practices - collection and treatment of various types of wastes.
- To impart knowledge on waste remediation and recycling processes.

UNIT – I:

Introduction to waste and pollution: Wastes - Introduction, sources, collection, characteristics, composition, types of wastes – Global scenario of wastes - wastes generation per capita - Wastes collection, storage, segregation – disposal methods - sanitary land fillings.

UNIT – II:

Municipal Solid wastes management: MSW – Sources, types, collection, transportation and disposal – Waste segregation, resource recovery, recovery of recyclable and non-recyclable wastes – reuse and recycling of MSW – Disposal – Incineration, pyrolysis, composing, aerobic and anaerobic digestion. Biomedical wastes – source, types, disposal principles.

UNIT – III:

Hazardous Waste Management: Introduction, characteristics, sources – Types of hazardous wastes (industrial, hospital, domestic) – Handling of hazardous solid wastes – segregation and recovery – Disposal of hazardous wastes – Radioactive hazardous wastes – source, types, control, management and remediation.

UNIT - IV:

Plastic and E-wastes: Plastic wastes - Sources, Facts and figures of plastic wastes in national and international level, environmental effects and control measures – E-wastes – sources, types, recovery, reuse – E-wastes pollutant chemicals - E-wastes Environmental impacts.

UNIT – V:

Remediation of Pollutants: Bioremediation - Description – Biostimulation, Gaseous nutrient stimulation organic liquid stimulation – Bio-augmentation – Limitations and Concerns – Biofertilizer technology – Bio composting techniques.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Treatment of different industrial wastewater distilleries, tanneries, dyeing industries, Removal of dissolved solids, Water auditing, waste water irrigation, biochar for waste water treatment.

REFERENCES:

1. Choudharay DK, (2012). Waste Management and Bioremediation. Oxford Book Company
2. Singh J and Ramanathan AL, Solid Waste Management – Present and Future Challenges. I.K. International Publishing House. Pvt. Ltd.
3. Subash Anand, (2010). Solid Waste Management, Mittal Publication, New Delhi
4. Rakesh Johri, (2008). E-waste implications, regulations & Management in India and Current global best practices, TERI Press, New Delhi
5. John Pitchel, (2005). Waste Management Practices, Municipal, Hazardous, and Industrial. Taylor & Francis Group, LLC
6. Bhide and Sundaresan, (2000). Solid Waste Management in Developing Countries – Indian National Scientific Documentation Center, New Delhi
7. CPHEEO, (2010). Technical EIA Guidance Manual for Common Municipal Solid Waste Management Facilities
8. CPHEEO, (2000). Manual on Solid Waste Management
9. Hester RE and RM Harrison, (2009) Electronic Waste Management, Design Analysis & Application, RSC Publishing, UK
10. http://cpcb.nic.in/
11. http://www3.epa.gov/epawaste/nonhaz/municipal/
12. http://www.cpeo.org/techtree/ttdescript/pyrols.htm
13. www.satavic.org/vermicomposting.htm
14. http://web.mit.edu/urbanupgrading/urbanenvironment/sectors/solid-wastelandfills.html
15. www.cement.org/waste/wt_apps_radioactive.asp
16. www.ipma.co.in/recycle.asp
17. www.algae.info
18. http://www.epa.vic.gov.au/business-and-industry/lower-your-impact/~/media/Files/bus/EREP/docs/EREP-waste-management-seminar.pdf
19. http://www.tn.gov.in/dtp/publications/SWM/SWM_161to184.pdf
20. http://energy.gov/em/services/waste-management
21. https://www.unesco-ihe.org/online-course-solid-waste-management
22. http://www.bostonelectronicwaste.com/go-green/what-is-ewaste
23. http://www.ces.iisc.ernet.in/energy/paper/ewaste/ewaste.html
24. http://ec.europa.eu/environment/waste/plastic_waste.htm

COURSEOUTCOMES:

- The learner would understand about the physic co chemical and biological characteristics of the water and waste water.
- The paper gives clarity about the different sources of freshwater.
- The importance of water shed management is clearly explained.
- The treatment techniques available for drinking and waste water is made clear.
- The student could get employed in waste water treatment plants, industries, STP's, Pollution control boards or could promoted omesticor industrial waste water treatment by himself/herself.
- The final unit is a self - study unit which could motivate the student and paves way for him/her to understand further details regarding waste treatment.

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Third Year **CORE COURSE IX** **Semester VI**

ENVIRONMENTAL TOXICOLOGY

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES

- To impart the knowledge of principals and scope of toxicology.
- To gain the knowledge about the factors influence the toxicity

UNIT - I:

Basic concepts of Toxicology: Principles of Toxicology – Scope of Toxicology – Dose response relationship, concept of LC_{50}, LD_{50} and ED_{50} – Types of toxic substances: Degradable and non-degradable – Acute and chronic toxicity – Synergism and Antagonism – Sigmoid relationships – Chemical and biological factors influencing toxicity

UNIT - II:

Toxicants in the Environment: Toxic substances in the environment, their sources and entry routes – exposure of toxicants by air, water, soil and diet. Bioaccumulation, bio magnifications and biotransformation of toxic materials in food chain.

UNIT - III:

Dose-Response Relationships: Graded response – Quantal response, Time action curves – Threshold limit value (TLV) – Margin of safety – Toxicity curves. Physiological and metabolic effects on flora and fauna.

UNIT - IV:

Toxicity Testing: Methods used to assess toxicity, Bioassay – types, characteristics, significance and Limitations. Bioassay methods using plant, animal and microbial models – Teratogenicity, carcinogenicity and mutagenicity

UNIT - V:

Organ toxicity: Hepatotoxicity: Common examples of hepatotoxicants, Nepherotoxicity: Common examples of nepherotoxicants, Pulmonary toxicity: Common examples of pulmonary toxicants, Neurotoxicity: Common examples of neurotoxicants.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Case studies with respect to the toxicants released from Tannery, Fertilizer, Electroplating, Cement and other relevant Industries.

REFERENCES:

1. Casseret LJ and Doull J (1982) Toxicology. The Basic Science of Poisons. Macmillan Publishers, New York.
2. Curtis D. Klaassen, John B. Watkins (2015) Casarett&Doull's Essentials of Toxicology, Third Edition, McGraw Hill Professional.
3. David Woolley, Adam Woolley (2008) A Guide to Practical Toxicology: Evaluation, Prediction, and Risk, Second Edition, CRC Press, USA.
4. Donald W. Sparling (2017) Basics of Ecotoxicology, CRC Press/Taylor & Francis Group, USA.

5. Kaiden Higgins (2017) Environmental Toxicology, Larsen and Keller Education, USA.
6. Shaw I and Chadwick J (1998) Principles of Environmental Toxicology, CRC Press, USA.
7. Stephen M. Roberts, Robert C. James, Phillip L. Williams (2015) Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, New Jersey, USA.
8. William Hughes (1996) Essentials of Environmental Toxicology, Taylor & Francis, USA.
9. www.fss.txstate.edu/ehsrm/safetymanual/chemical/toxchems.htm
10. https://www.ncbi.nlm.nih.gov/pubmed/2671129
11. https://onlinelibrary.wiley.com/doi/10.1002/0471646776.ch27/summary
12. https://www.sciencedirect.com/topics/pharmacology-toxicology/pesticide-toxicology
13. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/biomagnification
14. pubs.acs.org/doi/abs/10.1021/bk-1984-0239.ch004
15. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3917169/
16. www.rroij.com/…/principles-involved-in-bioassay-by-different-methods-a-minireview
17. https://www.sciencedirect.com/topics/pharmacology-toxicology-and/organ-toxicity

COURSE OUTCOMES:

- This course is designed to provide an outline toxicology, including an introduction of them ajor classes of pollutants, their fate in the environment, their disposition in organisms and their mechanism so toxicity.
- The toxicity assessment of pollutants in biological and environmental systems is also included.
- Introduces the basis of toxicology and gives an over view about natural and an thropogenic toxicants
- The learner could understand the entry, distribution and mode of action of the toxicants in the environment
- Describe the effects of toxicants in various systems liker espiratory, excretory, reproductive and cardiovascular.
- The toxicity testing methods and assessments of risks caused by toxicants is included.
- One can understand the role of ecotoxicogenomics for environmental monitoring and toxicant identification.

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Third Year	**CORE PRACTICAL VI**	**Semester VI**
	ENVIRONMENTAL TOXICOLOGY	
Code	**(Practical)**	**Credit: 4**

COURSE OBJECTIVE:

This course helps the students to understand the significance of various water quality parameters to understand the quality of the water tested. The soil quality is also known by analyzing the basic parameters. Further to understand the effects toxicants on animal model and it can be used to detect in humans too.

EXPERIMENTS:

INSTRUMENTAL METHODS OF ANALYSIS:

1. Paper Chromatography
2. Thin-layer Chromatography
3. Determinationofpesticidesinwatersamplesusingliquid-liquidextraction
4. Estimation of copper from pesticides
5. Estimation of Total Organic Matter
6. Determination of Dissolved Oxygen
7. Determination of Biological Oxygen Demond.
8. Determination of Chemical Oxygen Demond from Waste Water
9. Estimation of Chromium by colorimetric method
10. Estimation of Lead
11. Estimation of Sulphate
12. Isolation and estimation of chlorophyll by UV-spectrophotometry
13. Identification of Pollution Indicators – (Plants, Planktons and Microbes)

REFERENCES:

1. APHA (2012), Standard Methods for Examination of water and waste water, 22nd Ed., American Public Health Association, New York.
2. Trivedy, R.K. and Goel, P.K., (1986), Chemical and biological methods for water pollution studies, Environmental Publications, Kared, Maharashtra

COURSE OUTCOMES:

- Operate instruments independently for various analysis
- Understand the methods and technology of toxicity analysis
- Explain the collection, handling and preservation of the environmental samples

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Third Year	**MAJOR BASED ELECTIVE II 1) ECO TOURISM**	**Semester VI**
Code	**(Theory)**	**Credit: 4**

COURSE OBJECTIVE:

- This course introduces the students to the economic, cultural and environmental impacts of ecotourism.
- The students will also be aware of the different ecotourist spots and its activities. They will be also prepared to analyse and understand ecotourism as a significant aspect of tourism in future.
- To create awareness on the different ecotourism spots and their conservation
- To introduce the students to the environmental, cultural and economic impacts of ecotourism

UNIT – I:

Introduction to Tourism and Ecotourism: Concepts of Tourism–Classification of Tourism – Religious – Cultural – Heritage – Monumental – Adventure – Mass – Sustainable – Consumptive and Non-Consumptive Tourism. Introduction to Ecotourism – Concepts, History and Origin, Objectives and Benefits of Ecotourism–Factors affecting Ecotourism.

UNIT – II:

Ecotourism Spots: Places of interests of Ecotourism – Eco circuit of the Eastern and Western Ghats (India) – Infrastructural Facilities for Ecotourism –Maintenance of Ecological Centres –Important Biosphere Reserves. Target group of Ecotourism

UNIT - III

Ecotourism, Types and Conservation: Types of Ecotourism – Rain forest – Mountain, Polar, Islands and Coasts – Wilderness – Total Quality Management (TQM) of Ecotourism Resorts, Knowledge, skills, attitude and commitment of ecotourism service providers. Biodiversity Conservation and Sustainable Ecotourism, Community Based Tourism for Conservation and Development. Conservation – In situ and Ex situ (Sanctuaries, National Parks, Gene Banks, Seed Banks, Ova Bank).

UNIT – IV:

Impact of Ecotourism: Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research-Disasters and Ecotourism – Role of ethicsineco tourism – Advantages and Limitations of Ecotourism – Eco-branding, Green washing and Eco-labeling of Ecotourism Products – Marketing of Ecotourism, Ecotourism and Sustainable Development – Management Issues in Ecotourism, Ecotourism based/related employment, Scope and are as of employment.

UNIT –V:

Case Studies of Ecotourism: *Case Study –Parambikulam Tiger Reserve, Kaziranga National Park, Ecotourism spots in Tamil Nadu (Ooty, Kodaikanal, Elagiri, Yerkaud). A World Heritage Site in Assam, Ecotourism in Bagalkot District, Karnataka, The Kabini River Lodge. Gender and Sustainable Development in Mountains in Garhwal Himalaya, Fambonglho Wildlife Sanctuary, Sikkim–Ecotourism Potential in Tripura, North East India. Role of NGO'sin Ecotourism and capacity building. Ecotourism and Community*

Development: Case Studies from Hainan, China

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Virtual ecotourism, Leishmaniasis transmission in an eco tourism area of Brazil. SWOT analys is of Ecotourism.

REFERENCES:

1. Case studies in ecotourism, Buckley, R. (2003), Cambridge: CABI.
2. Ecotourism and sustainable Development, N. Mukherjee (2008). Cybetech Publications
3. Ecotourism Impacts, Potentials and Possibilities, Wearing and Neil (2000), Oxford: Butter worth & Heinemann.
4. Ecotourism, Page, S.J. and R.K. Dowling. (2002).New York: Prentice Hall.
5. Ecotourism, Weaver, D. (2001). Milton: John Wiley & Sons
6. Ecotourism. An Introduction, Fennell A David. (2003),Rout ledge, London and New York.
7. Ecotourism: a guide for planners and managers, Lindberg, K. and D.E. Hawkins. (eds).(1993), North Benninton: The Ecotourism Society.
8. Ecotourism: Management and Assessment, Diamantis, D. (2004), London: Thomson.
9. Encyclopedia of Ecotourism, Volume I, II and III, Sinha, P.C(2003), Anmol Publications Pvt. Ltd.,
10. Environmental impacts of ecotourism, Buckley, R. ed. (2004), Oxford shire: CABI.
11. Facing the wild: ecotourism, conservation, and animal encounters, Bulbeck, C. (2005), London: Earth scan.
12. Global Ecotourism, Prabhas Chandra (2003), Kaniskha Publishers
13. The Encyclopedia of Ecotourism, Weaver, D.B. (2001), CABI.
14. Tourism,ecotourism,andprotectedareas.CeballosLascurain,H.(1996),Gland:IUCN
15. http://www.vecotourism.org/news/category/internet-technology/
16. https://parasitesandvectors.biomedcentral.com/articles/10.1186/1756-3305-6-325
17. http://media.unwto.org/press-release/2013-01-03/un-general-assembly-ecotourism-key-eradicating-poverty-and-protecting- envir
18. http://sdt.unwto.org/content/ecotourism-and-protected-areas
19. http://tourism.gov.in/eco-tourism

COURSE OUTCOMES:

The student studying this course would be able to:

- Understand the basic principles and practice Safeco-tourism
- Understand the importance of ecotourism.
- The link between ecotourism and reduction in poverty levels can be describe.
- Explain the human factors that have an impact on eco-tourism.
- Describe how environmental protection canlead to poverty reduction.
- Students would be aware of the benefits of ecotourism
- Learner could elaborate on various aspects of eco-tourism.

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Third Year **MAJOR BASED ELECTIVE II** **Semester VI**

2) ENVIRONMENTAL LAW AND POLICY

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To make students aware of Indiana's well as International environmental laws and their importance.
- To develop an ethical consideration to environment and its components

UNIT – I:

Environmental Policy and Laws. Constitutional and Statutory laws in India: fundamental rights of India related to Environmental Protection –Indian policies and legislations pertaining to Environmental Conservation and Protection. Environmental acts related to Air, Water, forest, atomic energy production and usage and factory act.

UNIT – II:

Evolution and Development on national Laws. Protected areas - Endangered wildlife, Red list –International Union for Conservation of Nature (IUCN), World Wildlife Fund (WWF), Wildlife Conservation Society (WCS).

UNIT – III:

National Policy on EIA and Regulatory Framework: Rule & Regulation of Central & Sate Government and Pollution Control Boards for safeguard for Environmental Protection. Wildlife Protection Act, 1972 amended 1991, Forest Conservation Act, 1980; Indian Forests Actrevised1982.

UNIT – IV:

Movements related to Environment Sacred groves, Bishnoi tradition, Chipko movement, Narmada dam, Silent Valley. Tamil Nadu Tanneries, Doon Valley, Span motels private limited case. Bio-Medical Waste (Management and Handling) Rules, 1998. Issues involved in enforcement of environmental legislation, public awareness, public interest litigations (PILs).

UNIT – V:

Environmental Ethics : Concept of environmental ethics; Biocentrism and Eco centrism; Application of ethics to environmental issues: Ecofeminism.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Discussion of prevention control and abatement of Environmental pollution, Brain storming on natural resources conservation and the Judicial response towards Environmental Protection

REFERNCES:

1. Leelakrishnan, P. (2016). Environmental law in India. Lexis Nexis.
2. Dwivedi, O.P. (2016). India's Environmental Policies, Programmes and Stewardship. Springer.
3. Mc Guire, C.J. (2014.Environmental Law from the Policy Perspective: Understanding how legal frameworks influence environmental problem solving. Rout ledge.
4. Bell, S., Mc Gillivray, D., Pedersen, O., Lees, E.,& Stokes, E. (2017). Environmental law. Oxford University.
5. JacobI. Bregman, Robert D. Edell, Environmental Compliance Handbook, 2016, Lewis Publications
6. Ashford, Nicholas Askounes, and Charles C. Caldart. (2008) Environmental law, policy, and economics: Reclaiming the environmental agenda. Mit Press.
7. Fletcher, S.R. (Ed.). (2008). Environmental Laws: Summaries of Major Statutes Administered by the Environmental Protection Agency (EPA). Nova Publishers.
8. https://www.coursera.org/learn/environmental-law
9. https://www.esf.edu
10. https://indianlegalsolution.com
11. https://www.mondaq.com
12. http://www.envis.harayana.gov.in

COURSE OUTCOMES:

On completion of the course, the student will be able to:

- Be familiar with the laws, policies in the field of Environment
- Acquire the skills needed for interpreting laws, policies and judicial decision sin holistic approach
- Acquire the ability to evaluate the role of laws and policies in conservation and Management of natural resources and prevention of pollution.

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Third Year **PROJECT** **Semester-VI**

Code: **Credit: 3**

The candidate shall be required to take up a Project Work by group or individual and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the students in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT/EVALUATION/VIVA VOCE:

1. PROJECT REPORT EVALUATION (Both Internal & External)

   I. Plan of the Project - 20 marks

   II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc. and presentation of the report. - 45 marks

   III. Individual initiative - 15 marks

2. Viva-Voce / Internal & External - 20 marks

TOTAL **- 100 marks**

PASSING MINIMUM:

	Vivo-Voce 20 Marks	**Dissertation 80 Marks**
Project	40% out of 20 Marks (i.e. 8 Marks)	40% out of 80 marks (i.e. 32 marks)

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.

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Third Year	**SKILL BASED ELECTIVE II RRR STRATEGIES**	**Semester VI**
Code	**(Theory)**	**Credit: 2**

COURSE OBJECTIVE:

- To understand the waste management techniques.
- To study the composting and energy recovery methods
- To make the student to gain knowledge on environmental management strategies

UNIT – I:

Introduction: Identification, characterization and quantification of types and sources of Solid Wastes in a community: Biodegradables, non-biodegradables, domestic hazardous wastes, e-wastes, plastic wastes. Development of source segregation and collection strategies of a community.

UNIT – II:

Reduce and Reuse: Scoping – reduction and reuse potential for wastes at source - domestic, institutional, organizational, commercial etc., at community – residential complex, street, local and municipal level and industrial level.

UNIT – III:

Recycle and Recovery: MRF (Material Recovery Facility) – Evaluation of flow of materials through MRF. Fate of materials. Biomining. Recycling of Materials – Plastics, construction and demolition wastes, paper wastes and other wastes.

UNIT – IV:

Bioconversion: Conversion into Bio-compost using aerobic methods; Wastes into compost – preparation of wastes, conversion processes into compost – Windrow method, vermicomposting method. Estimation of NPK of final product. Cost - benefit analysis and marketing

UNIT – V:

Energy Recovery: Energy Recovery; WTE processes. Biogas production through anaerobic digestion/bio-methanation, Energy from incineration, gasification, pyrolysis, palletization - RDF (Refuse Derived Fuels). Techniques

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Clean India and Green India, Millennium Development Goals (MDG), Swachh Bharat, Sustainable Development Goals (SDGs)

REFERENCES:

1. Anand, S. Solid Waste Management. Mittal Publications, Delhi. 2010
2. Ramachandra, T.V. Management of Municipal Solid Wastes. Commonwealth of

Learning, TERI, New Delhi. 2009.
3. Peavy, H.S. Rowe, D.R and Tchobanoglous, G. Environmental Engineering. McGraw Hill Book Co., New York, 1986.
4. Piers, A., Martinho, G., Rodrigues, S and Gomes, M.S. Sustainable Solid waste Collection and Management. Springer.
5. https://nptel.ac.in/courses/105/103/105103205/
6. http://mohua.gov.in/upload/uploadfiles/files/Part2.pdf
7. https://www.tandfonline.com/doi/full/10.1080/10962247.2017.1316326

COURSE OUTCOMES:

- Recall about waste & its characteristics, Global & Indian scenario of wastes.
- Give example of reduce and reuse at the different sources.
- Relate Recycle and Recovery of wastes.
- Explain the aerobic methods.
- Prepare waste into compost.
- Illustrate the Vermicomposting technologies.
- Analyze the cost-benefit and marketing.
- Appraise the energy recovery process from the wastes.
- Demonstrate the Biogas production through anaerobic digestion.

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