THIRUVALLUVAR UNIVERSITY

BACHELOR OF SCIENCE

B.Sc. ENVIRONMENTAL MANAGEMENT

DEGREE COURSE

CBCS PATTERN

(With effect from 2012-2013)

The Course of Study and the Scheme of Examinations

S.NO	Part	Study Components / Course Title		Ins. hrs /week	Credit	Title of the Paper	Maximum Marks		
SEMESTER I							**CIA**	**Uni. Exam**	**Total**
1	I	Language	Paper-1	6	4	Tamil/Other Languages	25	75	100
2	II	English	Paper-1	6	4	English	25	75	100
3	III	Core Theory	Paper-1	6	4	Fundamentals of Earth Science	25	75	100
	III	Core Practical	Practical-1	3	0	Earth Science	0	0	0
4	III	ALLIED -1	Paper-1	4	4	Environmental Zoology	15	60	75
	III	ALLIED-1 PRACTICAL	Practical-1	3	0	Environmental Zoology	0	0	0
5	IV	Environ. Studies		2	2	Environmental Studies	10	40	50
				30	**18**		**100**	**325**	**425**
SEMESTER II							**CIA**	**Uni. Exam**	**Total**
6	I	Language	Paper-2	6	4	Tamil/Other Languages	25	75	100
7	II	English	Paper-2	4	4	English	25	75	100
8	III	Core Theory	Paper-2	6	5	Environmental Ecology	25	75	100
9	III	Core Practical	Practical-1	3	3	Earth Science and Environmental Ecology	40	60	100
10	III	ALLIED-1	Paper-2	4	4	Environmental Botany	15	60	75
11	III	ALLIED-1 PRACTICAL	Practical-1	3	2	Environmental Zoology & Environmental Botany	10	40	50
12	IV	Value Education		2	2	Value Education	0	50	50
13	IV	Soft Skill		2	1	Soft Skill	10	40	50
				30	**25**		**150**	**475**	**625**

SEMESTER III							**CIA**	**Uni. Exam**	**Total**
14	III	Core Theory	Paper-3	5	3	Environmental Chemistry	25	75	100
15	III	Core Theory	Paper-4	5	3	Environmental Geography	25	75	100
16	III	Core Theory	Paper-5	5	3	Computer Applications and Bio-Statistics in Environmental Science	25	75	100
	III	Core Practical	Practical-2	3	0	Environmental Chemistry and Computer Science	0	0	0
17	III	ALLIED-2	Paper-3	7	4	Environmental Economics	25	75	100
18	IV	Skill based Subject	Paper-1	3	3	Aquaculture	15	60	75
19	IV	Non-major elective	Paper-1	2	2	Global Warming and Climate Change	10	40	50
				30	**18**		**125**	**400**	**525**
SEMESTER IV							**CIA**	**Uni. Exam**	**Total**
20	III	Core Theory	Paper-6	5	4	Environmental Toxicology	25	75	100
21	III	Core Theory	Paper-7	5	4	Environmental Microbiology	25	75	100
22	III	Core Theory	Paper-8	5	3	Natural Resources & Management	25	75	100
23	III	Core Practical	Practical-2	0	4	Environmental Chemistry and Computer Science	40	60	100
24	III	Core Practical	Practical-2	3	3	Environmental Toxicology and Microbiology	40	60	100
25	III	ALLIED-2	Paper-4	7	4	Environmental Eco-tourism	25	75	100
26	IV	Skill based Subject	Paper-2	3	3	Solid waste management & Sewage Treatment Practices	15	60	75
27	IV	Non-major elective	Paper-2	2	2	Environmental Safety, Health and Management	10	40	50
				30	**27**		**205**	**520**	**725**
SEMESTER V							**CIA**	**Uni. Exam**	**Total**
28	III	Core Theory	Paper-9	6	5	Methodology in Environmental Analysis	25	75	100
	III	Core Theory	Paper-10	6	5	Environmental Pollution and Management	25	75	100
29	III	Core Theory	Paper-11	6	5	Principles of Management	25	75	100
	III	Core Practical	Practical-3	3	0	Methodology in Environmental Analysis & Management	0	0	0
31	III	Elective	Paper-1	6	3	Environmental Impact Assessment	25	75	100
32	IV	Skill based Subject	Paper-3	3	3	Forest Conservation & Management	15	60	75
				30	**21**		**115**	**360**	**475**

SEMESTER VI							CIA	Uni. Exam	Total
33	III	Core Theory	Paper-12	4	4	Conservation Biology and Management	25	75	100
34	III	Core Theory	Paper-13	4	4	Disaster Management	25	75	100
35	III	Core Theory	Paper-14	4	4	Environmental Safety, Health and Management	25	75	100
36	III	Core Practical	Practical-4	0	6	Methodology in Environmental Analysis & Management	40	60	100
37	III	Core Project	Paper-15	15	9	Project	50	150	200
40	IV	Skill based Subject	Paper-4	3	3	Environmental Energy Audit	15	60	75
41	V	Extension Activities		0	1		50	0	50
		Total		**30**	**31**		**230**	**495**	**725**

Part	Subject	Papers	Credit	Total credits	Marks	Total Marks
Part I	Languages	2	4	8	100	200
Part II	English	2	4	8	100	200
Part III	Allied (Odd Sem)	2	4	8	75+100 (I +III SEM)	175
	Allied (Even Sem)	2	4 (4+6) (II & IV SEM)	10	75+100 (II +IV SEM)	175
	Allied -Prac(Even Sem)	1	2	2	50	50
	Electives	1	3	3	100	100
	Core	14	(3-7)	54	100	1400
	Core Practical	4		19	100	400
	Core Project	1	6	6	200	200
Part IV	Environmental Science	1	2	2	50	50
	Soft Skill	1	1	1	50	50
	Value Education	1	2	2	50	50
	Lang. & Others/NME	2	2	4	50	100
	Skill Based	4	3	12	75	300
Part V	Extension	1	1	1	50	50
	Total	**39**		**140**		**3500**

THIRUVALLUVAR UNIVERSITY

B.Sc. ENVIRONMENTAL MANAGEMENT

SYLLABUS
CBCS PATTERN
(With effect from 2012-2013)

SEMESTER I

PAPER - 1

FUNDAMENTALS OF EARTH SCIENCE

UNIT – I

Earth – Its interior and surface: The Universe – Big Bang theory – Meteors. The origin, shape and size of the earth. The solar system – Planets. Eclipses – Solar, Lunar. Rotation and Revolution of the earth – Seasons – Latitude and Longitude - Layers of the earth - Sial, Sima, Nife - History of the Earth's surface - Precambrian, Paleozoic, Mesozoic, Neozoic and Quaternary era.

UNIT – II

Earth's Crust**:** Formation of Rocks - Igneous rocks: Intrusive and Extrusive; Plutonic rocks – Dyke rocks: Acid and Basic rocks – Sedimentary rocks: Inorganic and Organic – Sand stones, clay shales, gravels, pebbles, breccias – Metamorphic rocks – Regional and contact metamorphism.

UNIT – III

Major land forms and their transformation: Theories and stages of mountain building – Classification of mountains – Types of Plateaus : Intermontane, Piedmont, Continental – Hill lands – Plains – Classification – coastal – Destructional and Depositional plains.

UNIT – IV

Denudation and its agents: Weathering – Mechanical and chemical – Agents of weathering – Insolation, frost, plants, winds and gases. Agents of Denudation: Running water, Underground water, moving ice, wind, waves and breakers.

UNIT – V

Soil and its types: Composition, formation and types of soils – Origin of the soil – texture of the soil – Soil horizons and profiles – Soils of the world: Laterites, Red soil, Black cotton soil, Podsols, Praire soils, Chestnut soils – Laterisation.

Reference:

1. Das Gupta, A and A. N. Kapoor (Eds) (1999) Principles of Physical Geography. Twentieth edition. S. Chand and Co ltd., New Delhi.
2. Keller, E. A. (2005) Introduction to Environmental Geology. Prentice Hall Pub., NY.
3. De Blij, H. J., and Peter O. Muller (1993) Physical Geography of the Environment. John Willey and sons, Inc. Brisbane.
4. Strahler and Strahler (1970) Environmental Geology. Willey and Sons, NY.

ALLIED - 1

PAPER - 1

ENVIRONMENTAL ZOOLOGY

UNIT – I

Classification of Animals – Practical, artificial Natural system of classification – Binomial nomenclature – Modern classification of living organisms – Branches of science related to zoology – Discoverers.

UNIT – II

Physiology – definition – brief history – fields of Physiology – Branches of Physiology – embryology – Program of development – Historical thoughts – Concepts – Branches of embryology – Scope of Embryology Branches of Genetics.

UNIT – III

Definition - History – Vapour theory - fluid theory – epigenic theory – particulate theory – Performation theory – Pangenic theory – germ plasm theory.

UNIT – IV

Animal distribution – Classification of animal distribution – Patterns of distribution – Composition distribution – discontinuous distribution – Bipolar distribution – isolation distribution, factors affecting distribution.

UNIT – V

Economic zoology – Economic importance of protozoans in relation to health. Helminth parasites and diseases. Productive insects – Honey bee – silk worm – Lac insects.

Reference:

1. Sharma S. K. and S. K. Sharma (2002) Tips on Zoology - Krishna Prakashan Media (p) Ltd.
2. Verma, P. S., V.K. Agarwal and B.S. Tyagi (2002) Animal Physiology and Ecology, - S. Chand and Company, New Delhi.
3. Meyyan, R. P. (1988) Genetics, Saras publications.
4. Jayaraj, (1988) Fundamentals of Ecology - Veer Bala Rastogi,. S. Chand and Company, New Delhi.

SEMESTER II

PAPER - 2

ENVIRONMENTAL ECOLOGY

UNIT-I

Importance and Scope of Ecology – Environmental factors – Climate – Temperature – Light – Humidity – Edaphic and Biotic factors.

UNIT-II

Habitat and ecological niche: Study of pond, grass – land, forest, mangrove ecosystem – concept of energy, food chain, food web and ecological pyramids.

UNIT-III

Population ecology: Basic concept of population - Natality, Mortality - Age distribution - Survivorship curves - Ecotone and edge effect.

UNIT-IV

Community ecology: Definition – Ecological dominance, Ecotone – Edge Effect, Ecological equivalents, indicators, succession and climax.

UNIT-V

Animal Association – Interspecific interactions and Intraspecific interactions - Symbiosis, Mutualism, Antagonism, Commensalism, Predation and Parasitic relationships.

References:

1. Odum, E. P., (1971) Fundamentals of Ecology, W. B., Saunders Company, Philadelphia.
2. Shiva, V and Bandyopadyaya, J, (1986) Chipko, the INTACH, New Delhi.
3. Sharma, P. D. 1998, Ecology and Environment, Rastogi publication, Meerut
4. Jeyaraj, M. S. and Veer Bala Rastogi, (1998) Animal Ecology and Distribution of Animals.
5. Verma, P.S., and V. K. Agarwal, (1983) Principles of Ecology, S. Chand and Company Ltd., New Delhi.

CORE PRACTICAL

PAPER 1

EARTH SCIENCE AND ENVIRONMENTAL ECOLOGY

1. Identification of type of rock – Igneous, sedimentary and discuss their properties.
2. Identification of Soil texture – clay, sand, loamy.
3. Identification of Soil types – red soil, black soil.
4. Diagrammatic representation of solar, lunar eclipses, day and night.
5. Identification of coal fields – Economic aspects, availability of coal or Usage of topographic maps – to study about land forms
6. Submission of 10 herbarium sheets with proper field note book for practical examination
7. Study of vegetation by chart Quadrat, Frequency and Relative Frequency methods.
8. Estimation of species diversity by Shannon - Weiner diversity index method.
9. Squash preparation of onion root tip.
10. Separation of plant pigments by paper chromatography.

ALLIED - 1

PAPER - 2

ENVIRONMENTAL BOTANY

UNIT – I

Fundamentals of classification. Basic unit of classification – Classification of Plants – Taxonomic hierarchy – Artificial and Natural classification.

UNIT – II

Diversity of plant species – Trees, shrubs, herbs, grasses – halophytes, hydrophytes, mesophytes and xerophytes.

UNIT – III

Anatomy: Dicot – stem, root, monocot – stem, leaf. Vegetation (forest types): Moist deciduous, dry deciduous, ever green, semi-evergreen, grassland, thorn forest, mangroves.

UNIT – IV

Mendalism – Monohybrid and dihybrid cross, Origin of life – Theories of Evolution. Lamarck, Charles Darwin and De – vries.

UNIT – V

Economic botany – Medicinal plants, edible oil seeds, pulses, vegetables, fruits, mushroom, single cell protein, Spirulina.

References:

1. Jeffery, C (1982) An Introduction of Plant Taxonomy, Cambridge, press.
2. Smith Gilbert, M (1995) Cryptogrammic Botany, VOL I &II, McGraw Hill,. New York,
3. Verma, P.S. and V.K. Agarwal, (1989) Principals of Ecology, S.Chand & Company, New Delhi.
4. Hill, A.W. (1951) Economic Botany. McGraw Hill Publications.
5. Dash, M.C (1995) Fundamentals of Ecology, M.C.Graw Hill Publications.
6. Mitra, S. (1994) Genetics - A Blue Print of life. Tata McGraw Hill.

ALLIED PRACTICAL I

ENVIRONMENTAL ZOOLOGY & ENVIRONMENTAL BOTANY

1. Plants as Pollution Indicators: At least 2 examples of Museum specimen or fresh sample.
2. Study on the morphology and anatomy of hydrophytes - Leaf, stem and petiole.
3. Study on the morphology and anatomy of xerophytes – Leaf and stem.
4. Study on the morphology and anatomy of mesophytes – Leaf and stem.
5. Study on the morphology of halophytes - fresh samples or Museum specimens.
6. Demonstration of Microscope.
7. Identification and salient features of animals available (Prepared slides or Museum specimens)
8. Identification of Mendelian population - dominant – recessive by P.T.C. test.
9. Submission of Economically important insects available (charts) in your habitat.
10. Qualitative and quantitative analysis of zooplankton.

SEMESTER

PAPER - 3

ENVIRONMENTAL CHEMISTRY

UNIT – I

Fundamental concepts in chemistry – Elements and compounds – Atomic structure – Formation of molecules – Solutions: normality, molality and molarity – Ionization – radicals – Expressing concentrations.

UNIT – II

Properties of water – Hydrogen Bonding – covalent bonding – ionic bonding – Water quality parameters: physical & Chemical.

UNIT – III

Composition and structure of the atmosphere – Meteorological Parameters – humidity, wind direction and speed – temperature inversion – Green House Gases and Global Warming – Acid rain.

UNIT – IV

Nature of soil – Soil macro and micro nutrients – Soil structure and texture – Soil water – Soil air – Soil Temperature – Soil organic matter.

UNIT – V

Basic principle of Instrumentation and application of spectrophotometer – photometric laws – application of pH, conductivity meter and turbidity meter.

References:

1. Puri. B. R, L. R. Sharma and M .S. Pathima. (2004) Physical Chemistry, Vistal pub and co, Jalandar.
2. De, A. K. (2003) Environmental Sciences, Wilkey Eastern Hd, New Delhi.
3. Sharma. B. K. (1990) Instrumental Methods of Chemical Analysis, Geol pub House, Meerut.
4. Bhatia. S. C. (2002) Environmental Chemistry, CBS Publishers and Distributors, New Delhi.
5. Stanley E. Manahan (2005). Environmental Chemistry. CRC Press. 783 pages.

PAPER - 4

ENVIRONMENTAL GEOGRAPHY

UNIT – I

Continents and oceans – Landmasses Temperature of the Atmosphere – Insolation – heating of the atmosphere – Horizontal distribution of temperature and pressure – El Nino phenomenon.

UNIT – II

Hydrosphere – Movements of ocean – waves, currents, tides, drifts and creep. Lithosphere – layers of earth – Minerals and rocks – types of rock.

UNIT – III

Volcanoes – Types of volcanoes – volcanoes and landscape – Distribution of volcanoes. Earth quakes – Origin – Causes & types of earthquakes.

UNIT – IV

Variable winds – cyclones and anticyclones – Size & shape – velocity & speed. Moisture in the atmosphere – Humidity – Evaporation – Clouds – Types of rainfall.

UNIT – V

Biosphere – Climate, soil, plants and animals. Biomes – principal terrestrial biomes. Zoogeography beginning, zoogeography and its realms.

REFERENCES:

1. Edward A. Keller, (1981) Environmental Geology, 3rd Edition. Charles E. Merill Pub. Co. Ohio.
2. Strahler and Strahler (1970) Environmental Geology. Willey and Sons, NY.
3. De Blij, H. J., and Peter O. Muller, (1993) Physical Geography of the Environment. John Willey and sons, Inc. Brisbane.
4. Das Gupta, A., and Kapoor, A. N. (1986) Principles of Physical Geography. S. Chand and Company.

PAPER - 5

COMPUTER APPLICATIONS AND BIOSTATISTICS IN ENVIRONMENTAL SCIENCES

UNIT – I

Data – methods of Collection**.** Tabulation – types of tables. Diagrammatic and graphical representation.

UNIT – II

Measures of central tendency-Calculation of Mean, Median and Mode, Moments. Skewness and Kurtosis

UNIT – III

Measures of dispersion – range and deviations, Mean deviation, Standard deviation and standard error.

UNIT – IV

Introduction and basic concepts of computer, Parts of computer, types of Computer Number system, Computer organization, software, computer virus, C-language and its applications.

UNIT – V

Basic principles of a digital computer (Elementary knowledge – input – central processing unit – output– peripherals). Compression of hardware and software. Computer operating systems – WINDOWS - MS Word, Excel – Internet, World Wide Web, Search Engines, E-Mail.

REFERENCES:

1. Palanisamy, M (1989) A Text Book of Statistics, Paramount Publication, Palani.
2. Vittal, R.R (1986) Business Mathematics and Statistics, Murugan Publications.
3. Gupta, S.P. (1996) Statistical Methods, Sulthan chand and Sons Publications, New Delhi
4. Byron S Gottfried (1996) Programming with C, Hill Publishing Co, New Delhi.
5. Sanjay Saxena (2003) A First course in computers, Vikas publishing house Pvt. Ltd, New Delhi.

CORE PRACTICAL II

ENVIRONMENTAL CHEMISTRY AND COMPUTER SCIENCES

1. Calculation of Oxidation number of Cr in $K_2Cr_2O_7$, Mn in $KMnO_4$,
2. Standardization of pH with buffer solutions (4, 7 and 9).
3. Measurement of pH of acidic and basic solution using pH meter.
4. Volumetric titration – Strong acid vs Strong base. Calculation of end point using V1N1=V2N2.
5. Conductometric titration – Strong acid vs Strong base. Calculation of end point using graph.
6. Graphical representation of data.
7. Computation of mean, mode, median, standard deviation.
   (Using softwares – Excel, SYSTAT)

ALLIED - 2

PAPER - 3

ENVIRONMENTAL ECONOMICS

UNIT – I

Definition and Scope Environmental Economics: Introduction – Economics and Environment – Definition of Environmental Economics – Scope and Significance of Environmental Economics : Environment Inter-linkages – Market failure and externality – Accounting for the Environment – Pareto Optimality – Individual Choice vs Social Choice.

UNIT – II

Resource Economics: Natural Resources: Types and classification – Economics of Natural Resources Exploitation – Uses of Environment: Use Value, Existence Value and Optional Value – Market Structure and the Exploitation of Non-Renewable Resources.

UNIT – III

Conservation of Resources: Definition and Meaning – Material Substitution – Product Life Extension – Recycling – Optimum Recycling – Waste Management.

UNIT – IV

Environment and Sustainable Development: Environmental Cost of Economic Growth – Limits to Growth – Sustainable Development – Brundtland Commission – Sustainable Industrialization – Pollution Abatement and Control.

UNIT – V

Pollution Control: Basic Approach to Environmental Policy – Problem of pollution Control – Moral suasion – Direct control – Regulation – Prohibition – Pollution Tax – Effluent Charges and Subsidies – Common Effluent Treatment Plant.

REFERENCES:

1. Nick Hanley, Jainson F. Shorgen and Ben White (1999) Environmental Economics – In Theory and Practice. Macmillan India Ltd, New Delhi.
2. John Bowers (1997) Sustainability and Environmental Economics, Addison Weley Longman Ltd, Singapore.
3. David W. Pearce and Kerry R. Turner (1999) Economics of Natural Resources and the Environment. The Johns Hopkins University Press, Baltimore.
4. Kerry R. Turner, David W. Pearce and Ian Bateman (1993) Environmental Economics – An Elementary Introduction. The Johns Hopkins University Press, Baltimore.

SKILL BASED SUBJECT

PAPER - 1

AQUACULTURE

UNIT – I

Fish culture: Cultivable fresh water fishes – Culture Pond – Pond construction and management: Selection of site-soil quality – layout – inlet – outlet – dykes. Water quality Management – Fertilizing – Eradication of predators – weeds.

UNIT – II

Induced breeding – Seed – Procurement – Collection and Transport of seeds and breeders Types of hatcheries

UNIT – III

Economic importance of fishes – Nutritive value of fish – Crafts and gears.

UNIT – IV

Fish diseases: symptoms-treatment-prevention-Preservation and Processing of fish: Methods of preservation processing – Refrigeration, Deep freezing, Salting, Drying, Smoking, Canning, pickling. Causes for fish spoilage – Rigor mortis.

UNIT – V

Aquarium and Ornamental fishes – Aquarium tanks – maintenance – ornamental fishes

References:

1. Jhingaran, C.G.1981. Fish and Fisheries of India, Hindustan Publishing Corporation, Delhi.
2. Pillay,T.V.R. 1990. Aquaculture. Principles and Practices. Blackwell Publishing, Oxford. pp 575.
3. Srinivasulu Reddy, M and K.R.S Sambasiva Rao. 2004.A text book of Aquaculture. Discovery Publishing House, NewDelhi.
4. Talwar,P.K. and Jhingaran, A.G. 1991. Inland fishes of India and adjacent countries. Vols.I &II. Oxford and IBH Publishing Co.Pvt Ltd. New Delhi.

NON-MAJOR ELECTIVE

PAPER - 1

GLOBAL WARMING AND CLIMATE CHANGE

UNIT – I

Role of ozone in environment-ozone layer-ozone depleting gases-Green House Effect

UNIT – II

Temperature profile of the atmosphere – Laps rates – Temperature inversion – effects of inversion on pollution dispersion.

UNIT – III

Causes o f Climate change: Change of Temperature in the environment – melting of ice Pole-sea level rise – role of fossil fuels

UNIT – IV

Mitigation Measures – Cleaner production – alternative fuel measures

UNIT – V

Kyoto Protocol – Intergovernmental Panel on Climate change (IPCC).

REFERENCES:

1. Annon 1996. Climate change 1995: Adaptation and mitigation of climate change-Scientific Technical Analysis. Cambridge University Press, Cambridge.
2. Annon. 2001. Intergovernmental Panel on Climate change (IPCC) Climate change 2001. Third Assessment Report (Volume I). Cambridge University Press, Cambridge.
3. Annon.2005. World Health Organization. Climate and Health, Fact sheet, July.
4. Gosain, A.K. and Rao,S. 2003. Climate change and India: Vulnerability Assessment and Adaptation. Eds. Shukla,P.R. Universities Press Pvt. Ltd. Hyderabad. pp462.
5. Houghton,J. 2005. Global warming: The Complete Briefing. Cambridge: Cambridge University Press, Cambridge.

SEMESTER IV

PAPER - 6

ENVIRONMENTAL TOXICOLOGY

UNIT – I

Principles of toxicology – Introduction – classification of toxic agents – toxic responses – mechanisms of toxicity – reaction of the toxicant with target molecules.

UNIT – II

Factors influencing toxicity – abiotic and biotic factors – interaction of chemicals – bioaccumulation and biomagnifications – Bio chemical effects of CO, Nitrogen oxide, Sulphurdioxide, ozone & PAN.

UNIT – III

Risk assessment – introduction – definition, hazards identification, risk characterization – exposure assessment.

UNIT – IV

Production of mycotoxins in general – fungal toxins – bacterial toxins – exo and endo toxins – viral toxins, algal toxins – teratogen – carcinogen and mutagens – causes mode and evaluation.

UNIT – V

Chemistry of Toxicology – Pesticides – Heavy metals – cadmium – mercury – lead – chromium – zinc – Impact on Man animals & Plants.

REFERENCES :

1. Casseret, L. J and Doull, J (1982) Toxicology. The basic science of Poisons. Macmillan publishers, New York.
2. Stake, M. Y. Mido, M.S. Sethi, S.A. Iqbal, H. Yasuhisa, S. Taguchi (1997) environmental Toxicology, Discovery publishing house, New Delhi.
3. De, A. K. (1986) Environmental Chemistry, Willey Eastern Limited, New Delhi.
4. Timbrel (1989) Elements Toxicology, British Council Library.
5. Trivedy, R. K (1994) Encyclopaedia of Environmental Pollution and Control. Enviromedia publications, Karad.

PAPER - 7

ENVIRONMENTAL MICROBIOLOGY

UNIT–I

History and discovery of microorganisms – Spontaneous generation – Germ Theory of disease, Immunity – chemotherapy.

UNIT – II

Prokaryotic and Eukaryotic cell. Structure of bacteria, virus, fungi, yeast and Algae. Growth and reproduction of bacteria and virus.

UNIT – III

Sterilization-physical and chemical methods. Culture Techniques- Types of media. Micro organisms in Industry – Production of lactic acid, Aminoacid, Alcohol fermentation Penicillin Production.

UNIT – IV

Microorganisms in soil, air and water – Rhizosphere and Non – Rhizosphere microorganisms – Role of Microorganisms in carbon, nitrogen and sulphur cycle

UNIT – V

Microorganisms in food : milk, fruits, egg and Fish – Principles of food spoilage and food preservation. Microorganisms in sanitation

REFERENCES

1. Michael J. Pelczar, J.R.E.C.S. Chan Noel R.Krieg (1993) Microbiology, Tata Mc Graw Hill Edition, New Delhi.
2. Alexander, M (1961) Introduction to Soil Microbiology, John Wiley and Sons, Inc, New Delhi.
3. James M.Jaj (1986), Modern Food Microbiology, Third Edition, CBS Publishers & Distributors.

PAPER - 8

NATURAL RESOURCES & MANAGEMENT

UNIT – I

Introduction to Natural Resources – Classification of natural resources – List of natural resources – Values of natural resources – Demands on Natural Resources – Population, lifestyle and natural resources – Impact of poor natural resource management.

UNIT – II

Land resources – Land: Definition – Land use pattern in India. Waste Land: Types. Desertification: Definition – Causes and impacts.

UNIT – III

Water resources – Hydrological cycle – Surface water – Ground water: Dams: Uses and impacts on environment. Marine resources: Biotic and abiotic resources.

UNIT – IV

Living Resources – Agriculture – types of cultivation-high yielding varieties –HYV chemicals fertilizers & their impacts – Microbes – useful & harmful bacteria in soil, water, Air – fungi beneficial & harmful.

UNIT – V

Forest and Mineral Resources, forest produce – food – fodder – fuel wood. Fiber – Timber – Minerals –Metal & non metal resources, non – conventional energy resources

REFERENCES:

1. Bali, S (2000) Land Resource Management in India. Souvenir of International Conference on Land Resource Management for food, employment and environmental security, 9 – 13 November, 2000. Organized by Soil Conservation Society of India. Pp. 29 – 48.
2. Department of Land Resources (2000) Ministry of Rural Development, Government of India, New Delhi.
3. Kovda, V. A. (1977) Arid land Irrigation and soil fertility: Problems of salinity, alkalinity, compaction. In Arid land Irrigation in Developing Countries: Environmental Problems and Effects. Ed., by E. Barton Worthington. Oxford: Pergamon Press.
4. Agarwal, K.M., Sikdar, P.K., Deb., S.C (2005) A Text Book of Environment, Macmillan India Limited.

CORE PRACTICAL II

ENVIRONMENTAL CHEMISTRY AND COMPUTER SCIENCE

1. Calculation of Oxidation number of Cr in $K_2Cr_2O_7$, Mn in $KMnO_4$,
2. Standardization of pH with buffer solutions (4, 7 and 9).
3. Measurement of pH of acidic and basic solution using pH meter
4. Volumetric titration – Strong acid vs Strong base. Calculation of end point using V1N1=V2N2.
5. Conductometric titration – Strong acid vs Strong base. Calculation of end point using graph.
6. Graphical representation of data
7. Computation of mean, mode, median, standard deviation.
   (Using softwares – Excel, SYSTAT)

CORE PRACTICAL III

ENVIRONMENTAL TOXICOLOGY AND MICROBIOLOGY

1. Estimation of LC_{50} and LD_{50} for a given heavy metal using a suitable organisms
2. Demonstration – BOD
3. Preparation of culture media for Micro organisms
4. To show the presence of microorganisms around us.
5. Gram staining of bacteria.
6. Isolation of Microorganisms from the soil.
7. Observation of root nodule bacteria.
8. Isolation of root nodule bacteria.

ALLIED - 2

PAPER - 4

ENVIRONMENT AND ECO-TOURISM

UNIT-I

Scope and definitions: Objectives of tourism (geographical, social, economic, religious, cultural and environmental); Components of tourism (information services, transport and accommodation).

UNIT-II

Concepts of Tourism – Classification – Religious tourism – Cultural tourism – Heritage tourism – Monumental tourism – Adventure tourism – Mars tourism – Sustainable tourism – Consumptive & non consumptive tourism.

UNIT-III

Ecotourism – definition and characteristics features (Ecosystem & biodiversitiy), Goals (Social, economic and environmental); criteria (c0nservation, low impact and green efforts, sustainability, recreation, community involvement and environmental education and interpretation, Ecotourism in India.

UNIT-IV

Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Objectives of Ecotourism – benefits of Ecotourism – trends affecting ecotourism.

UNIT-V

Impact of Ecotourism – Economic impacts (fiscal impacts, concepts & Methods) – Types and degree of impacts from Ecotourism activities – Socio cultural impacts – Ecotourism related organization – Ecotourism Research disasters & Ecotourism. Eco certification, policies and regulations – ecotels & Ecomorals – Sustainable ecotourism.

REFERENCES:

1. Agarwal, A. N (1980) Indian Agriculture, Vikas publishing House, New Delhi.
2. Weaver, D. B (2001), The Encyclopedia of Ecotourism, CABI, Publishing, U.K.
3. Sinha, P. C (2003) Encyclopedia of Ecotourism, Vol – I, II & III, Anmol publications Pvt. Ltd, New Delhi.
4. Bhatia, A. K (1978) Tourism in India.

SKILL BASED SUBJECT

PAPER – 2

SOLID WASTE MANAGEMENT AND SEWAGE TREATMENT PRACTICES

UNIT – I

Solid waste generation – characteristics – Physico – chemical characteristics
Problems and Impacts of Municipal Solid Waste (MSW) – Methane emission due to MSW.

UNIT – II

Disposal of Municipal Solid Waste (MSW) – Collection – Process of waste collection. Segregation – Non – compostable – reusable – recyclable – non recyclable – compostable – hazardous.

UNIT – III

Composting types: Windrow method – Aerobic composting – Vermicomposting – Compost pit – Garbage filled compost pit-Composed garbage.

UNIT – IV

VERMITECH : Vermibank – Earthworm species – *Eisenia foetida, Eudrilus euginiae* – Morphology and life cycle.

UNIT – V

Vermicomposting –Sources of organic waste – Vermicompost Process –vermicast – Application of vermicompot – Preparation of organic by products: Vermi wash –Amritha karisal – Organic insecticide – Humic acid – Advantage of Vermitech.

REFERENCES:

1. Joseph,B. 2005. Environmental studies. Tata McGraw Hill Co.Ltd.
2. Edwards,C.A and Bohlen ,P.J. 1996. Biology and ecology of earthworms, 3rd ed., Chapman nand Hall, London.pp426.
3. Glynn Henry and Gary W.Henke.2004. Environmental Science and Engineering. Prentice Hall of India Pvt. Ltd.
4. Nath, K.J. 1984. Metropolitan solid waste management in India. In: Holmes JR, editor, managing solid waste in developing countries. New York. John Willey and Sons.pp304
5. Ramachandra,T.V. 2006. Management of Municipal solid waste. Capital Publishing Company.

NON MAJOR ELECTIVE

PAPER - 2

ENVIRONMENTAL SAFETY, HEALTH AND MANAGEMENT

UNIT – I

Definition- need for good health- factors affecting health. Types of diseases (deficiency, infection, pollution diseases). Personal hygiene- food (balanced diet). Food habits & cleanliness, food adulterants, avoiding smoking, drugs & alcohols.

UNIT – II

Public health: communicable diseases, mode of transmission (epidemic and endemic diseases). Management of hygiene in public places (railway stations, bus stands and other public places).

UNIT – III

Occupational health and safety. Occupational health and hazards-physical-chemical and biological. Occupational diseases – prevention and control.

UNIT – IV

Industrial safety and management techniques: Industrial safety standards and regulations. Accidents – definitions – prevention and control.

UNIT – V

Safety management system – concepts of safety management systems – EMS ISO 14000 and 14001. OSHA. Public Liability Insurance Act – Mining Act.

REFERENCES:

1. Scoot, R., M. 1997.Basic concepts of industrial hygiene, Lewis Publisher, New York.
2. Diberardins L.J., 1998.Hand book of occupational safety and health, John Willey, New York.
3. Park J.E. and Park, Preventive and social medicine.
4. Schilling R.S.E. 1973.Occupational health practice, Buffer Worth, London,
5. Khan M.A.O., John.P, Bederka.S. , 1974. Survival in toxic environment, Academic Press, New York.

SEMESTER V

PAPER - 9

METHODOLOGY IN ENVIRONMENTAL ANALYSIS

UNIT – I

Environmental analysis:

Water sampling:

Sampling stations-Collection of water samples – Handling and Preservation.

Water analysis:

Physical parameters: Colour – Temperature – Transparency – Turbidity.

UNIT- II

Chemical parameters: pH – Electrical conductivity – Total solids – Total suspended solids – Dissolved oxygen – Carbonates – bicarbonates – Hardness – Calcium – Magnesium – Total alkalinity – Fluoride – Iron – Nitrate – Nitrite –Phosphate
Biochemical Oxygen Demand (BOD) – Chemical Oxygen Demand (COD).

Biological Parameters: Macrophytes – Phytoplankton – Zooplankton – Primary Productivity. Bacteriological measurements-Standard Plate count method – MPN (Most Probable number)

UNIT- III

Soil /Sediment Analysis:

Physical parameters: Density – Specific gravity – Texture.

Chemical Parameters: pH-Electrical conductivity – Total Alkalinity – Chloride –Nitrates – Phosphate – Iron – organic matter

Biological parameters: Animal population – Benthos – Bacteria

UNIT – IV

Air Analysis:
Physical parameters: Wind velocity-Atmospheric pressure- Temperature-Humidity
Chemical Parameters: Carbon dioxide- Carbon monoxide-Sulphur dioxide-Nitrogen oxide-

UNIT- V

Remote sensing: Principle – Types. GIS – Components – Types of maps – Digitizer – Scanner – Scale of measurements.

REFERENCES:

1. Chhatwal, G.R, M.C.Mishra, M.Satake, T.Katyal, M.Katyal and T.Nagahiro. Anmol Publication Pvt Ltd., NewDelhi pp204.

2. Rao, C.S. Environmental Pollution Control Engineering. Wiley Eastern Limited New Age International Limited, New Delhi pp427.

3. Saxena, M.M. 1987. Environmental analysis-Water, soil and air. Agro Botanical Publishers, India.pp186.

PAPER - 10

ENVIRONMENTAL POLLUTION AND MANAGEMENT

UNIT – I

Water pollution – sources & types of water pollution – physical, chemical & biological – effect of water pollution. Drinking water quality standards waste water treatment – primary, secondary, tertiary-water pollution prevention & control act – 1974.

UNIT – II

Air pollution –structure and composition of atmosphere – classification, sources & effects of air pollution – Acid rain –green house effect – global warming – Ozone depletion.

UNIT – III

Prevention and control of air pollution particulate control – settling chamber, scrubber, bag filter, cyclones electrostatic precipitators. Gaseous emission control methods. Air pollution prevention and control Act 1981.

UNIT – IV

Soil Pollution – soil pollutants – types – sources, effects & Control. Noise Pollution – sources effects & Control.

UNIT – V

Government Agencies & Programs – The Tiwari committee – creation of NCEPC, Department of Environment & Forest – Function of State Pollution Control Board.

REFERENCES:

1. Rao, M. N and H.V.N. Rao (1993) Air Pollution, Tata McGraw – Hill Publishing Company Limited. New Delhi.
2. Kudesia, V.P and Ritu Kudesia (1992) Water Pollution, Pragati Prakashan Publication, Meerut.
3. Sawyer, C. N., P.L McCarty and G.F. Perkin (1994) Chemistry for Environmental Engineers, II Edition. McGraw-Hill.
4. Sharma, B.K and H.Kaur (1994) Soil and Noise Pollution. Goel Publishing House, Meerut.
5. Kumarasawmy, K., A. Alagappa Moses and M. Vasanthy (2004) Environmental Studies (A Text Book for All Under Graduate Students) Bharathidasan University Publications.

PAPER - 11

PRINCIPLES OF MANAGEMENT

UNIT-I

Functions of Management - Planning, Organising and Controlling, systems approach to Management, patterns of analysis, economic, social political and ethical factors affecting management practice.

UNIT-II

Steps in the planning process management by objectives, programme budgeting, capital budgeting, economic analysis - marginal analysis, benefit / cost analysis etc. decision analysis -risk and uncertainty decision tress, strategy and policy analysis, limitation of planning.

UNIT-III

Organisational structure, formal and informal organization, line and staff relations, relations with the public, principles of delegation, performance appraisal~ motivation, communication and leadership aspect, theories of organisation.

UNIT-IV

Management Control Systems, Feedback mechanism, control techniques - budgeting, programme evaluation and audits.

UNIT-V

Setting environmental goals, resource mobilization, use of natural resource and environmental indicators, output budgeting, monitoring and evaluating environmental programmes. Case studies in selected industries like garment manufacturing, tanneries focused on the economics and management of effluent treatment plants.

REFERENCES:

1. Kovntz, H and C. Danvel (1978): Essential of management, second edition, Tata Mc Graw Hill publishing company, New Delhi.
2. Sharma, R.D. (1976), Organisational Management, Light and Life Publishers, New Delhi.
3. Chakraborthy, S. K (1976), Management by objection Macmillan Co. of India Ltd., New Delhi.
4. Varma and Agarwal, Theory & practice of Management Forward Book Depot, New Delhi.

CORE PRACTICAL IV

METHODOLOGY IN ENVIRONMENTAL ANALYSIS AND MANAGEMENT

Water analysis:

1. Estimation of Turbidity
2. Estimation of pH
3. Estimation of Chloride
4. Estimation of Total dissolved solids-
5. Estimation of Dissolved oxygen-
6. Estimation of Carbonates-bicarbonates-
7. Estimation of Total Hardness
8. Estimation of Phosphate
9. Air Sampling (High volume air sampler) - Demonstration
10. Pollution Indicators.

ELECTIVE

PAPER - 1

ENVIRONMENTAL IMPACT ASSESSMENT

UNIT – I

EIA – Introduction – Concept of EIA- Scope and object of EIA – Organization responsible for EIA – Site selection and area classification- Siting and setting criteria for EIA projects.

UNIT – II

Description of the environmental setting – Inclusion or Exclusion of environmental Items – Some suggested approaches for developing a list of environmental Factors – Informational Sources for Environmental factors.

UNIT – III

Various steps of EIA – Content of EIA – Assessment methodology- Ad-hoc, Overlay, Network, Matrix and checklist. Cost benefit analysis – Case studies, Hydroelectric projects, Mining, Power plant Roads and airports.

UNIT – IV

Environmental Impact Assessment Notification (1994): Procedure for Environmental Clearance, List of the projects requiring Environmental Clearance, Composition of Expert Committee for Impact Assessment, Public hearing Committee, Procedure for public hearing – Project clearance.

UNIT – V

Detailed content of EIS – Use of visual display methods – Statement documentation – general writing suggestion.

REFERNCE BOOKS:

1. Rau, J.G. and Wooten, D.C (1980) Environmental Impact Analysis Hand Book, Mc Graw Hill, USA.
2. Canter, L. W. (1977) Environmental Impact Assessment. McGraw-Hill, New York.
3. Erickson, P.A. (1977) Environmental Impact Assessment – Principles an Applications McGraw-Hill, New York.
4. Munn, R. E. (1982) Environmental Impact Assessment. McGraw-Hill, New York.

SKILL BASED SUBJECT

PAPER - 3

FOREST CONSERVATION AND MANAGEMENT

UNIT-I

Forest cover – utilization & over exploitation of forest – deforestation – modes of deforestation – causes – impact of deforestation on environment.

UNIT-II

Forest resources – importance of forest – ecological significance – forest types. Visit to Afforestation areas.

UNIT-III

Utilization of forest products: Timber, fire wood, pulp, fodder, medicinal plants. Plant indicators. Forest check, flood & soil erosion – Sacred groves.

UNIT-IV

Forest Movement and people's participation – environmental protection – Tribal community
Forestry: Social forestry Afforestation – Agroforestry – Chipko movement – Apiko movement.

UNIT-V

Forest conservation – Protection from fire – Prevention of fire – Regulation of tree felling, fencing, protection from wild animals, control of pest- Forest conservation Act1980.

REFERENCES:

1. Kormondy, E.J. 2005.Concepts of Ecology. Prentice Hall of India Pvt Ltd. NewDelhi . pp559.
2. Clarke,G.L. 1954. Elements of Ecology. John Wiley and Sons, NewYork.
3. Chapman, R.N.1928. The quantitative analysis of environmental factors Ecology 9:111-122.
4. Champion H.G. & seth, 1965 A revised Survey of the forest types of India, Manager of publishers New Delhi.

SEMESTER VI

PAPER - 12

CONSERVATION BIOLOGY AND MANAGEMENT

UNIT-I

Biodiversity / Wildlife Conservation: Why Conservation? Importance and need of conservation. Loss of biodiversity: Reasons for biodiversity loss-Threats to biodiversity – habitat loss ,habitat fragmentation, overexploitation, poaching, fire, natural disasters. IUCN Threatened Species Categories: Red data book- Extinct, Endangered, Vulnerable, Rare.

UNIT-II

Biodiversity/Wildlife Management: Concepts and principles. Conservation Strategies-Methods of Conservation *In situ* Conservation - Wildlife Sanctuaries:
Mudumalai,Mundathurai, Kalakad, Point Calimere, Vedanthangal, National Parks: Guindy, Silent Valley, Bandipur, Kaziranga, Gir, Biosphere Reserves : Nilgiri, Gulf of Mannar, Nandadevi,

UNIT-III

Ex situ conservation: Botanic gardens, Zoological Parks (Zoos) ,Gene banks, Seed banks, DNA finger printing. Special projects for conservation: Project Tiger, Gir Lion project, Project elephant, Crocodile Project.

UNIT-IV

Wildlife Administration and Legislation. Wildlife (Protection) Act 1972 , Wildlife (Protection) Amendment Act,2002. Forest management- Afforestation-Social Forestry-Chipko movement.

UNIT-V

Role of Government and Non-Governmental organizations in biodiversity/wildlife conservation: Ministry of Environment and Forests, Bombay Natural History Society(BNHS) International Union for Conservation of Nature and Natural Resources(IUCN),World Wide Fund for Nature (WWF), Convention on Trade in Endangered Species of wildlife fauna (CITES), Biodiversity/Wildlife Education. Role of media.

REFERENCE:

1. Annon. The Wildlife (Protection) Act, (1972) Professional Book Publishers, Wildlife Protection Society of India, New Delhi. pp110
2. GilePrimack, R.B.(1993) Essentials of Conservation Biology. Sinauer Associates Inc. Publishers.Massachussets pp564
3. Richard. D., Teague (ed). (1989) A manual of wildlife conservation. The Wildlife society Washington. D.C. Natraj publishers, Dehra Dun. pp 206.
4. Woodroffe, G. (1981) Wildlife conservation and the modern zoo. Saiga publishing Co. Ltd. 1 Royal Parade, Hindhead, Surrey. Gu 26 6 TD, England. pp.208

PAPER - 13

DISASTER MANAGEMENT

UNIT-I

Disaster – Introduction –Types of natural calamities, major and minor calamities – impact of calamities.

UNIT-II

Natural disaster – cyclone – Tsunami – flood – Landslides – earth quake.

UNIT-III

Manmade disaster – Wars – Biological war (introduction of pathogens) – misuse of atomic bombs –major accidents from industries e.g. Bhopal. Lov canal disaster – London Smog.

UNIT-IV

Medical Management of disaster – Disaster Impacts and response – Identification of dead – Search rescue –first and relief phase – Vaccination, basic sanitation and personal hygiene.

UNIT-V

Environmental Disaster – Assessment, Planning – mitigation program – preparedness – resettlement rehabilitation – role of NGOS, Gos (relief camp), Psychotherapy – simplified yoga and meditation, stress management.

REFERENCES:

1. Tsunami. A text book from Department of Science and Technology, New Delhi, p90.
2. Proceedings “Brainstorming seminar on Disaster Management and Mitigation programmes. Sri Venkateswara University, Tirupati, P 150.
3. Pollution control Legislations. Environmental Laws – Vol. II. Tamilnadu Pollution Control Board.
4. Shailaendra K. Singh, Subash C. Kundan and Shobu Singh (1998). Disaster Management. Mittal Publications. New Delhi.
5. Natural disasters (1980) – A guide for relief workers – JAC Adhyatma Sadhema, Kendra Mehrani, New Delhi.

PAPER - 14

ENVIRONMENTAL SAFETY, HEALTH AND MANAGEMENT

UNIT – I

Definition; Need for good health; factors affecting health, types of diseases (Deficiency, infection, pollution diseases) Personal hygiene – Food (Balanced die) food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol.

UNIT – II

Public Health: Communicable diseases, Mode of transmission (Epidemic and endemic diseases), Management of Hygiene in public places (Railway stations, Bus stands and other public places) hospitals – Nosocomial infections and hygiene in Educational institutions.

UNIT – III

Occupational Health and Safety: Occupational health and hazards – physical, chemical and biological hazards. Principles of ergonomics. Occupational diseases – prevention and control. Health protection measures for workers – health education – first –aid. Management of medical emergencies.

UNIT – IV

Industrial Safety and Management techniques: Industrial Safety standards and regulations. Accidents – definition, frequency rate – prevention and control. Risk Analysis and assessment. Work study, work measurement – measurement of skills, Safety cost and expenses. Principles of functions and safety management.

UNIT – V

Safety Management System: Concepts of safety management systems. Environmental Management Systems (EMS) ISO 14000 and 14001. OSHA and NIOSH compliance, Compensation Act, Public Liability Insurance Act, Mining Act, Good Manufacturing Practices (GMP) and Good Laboratory Management Practices (GLP).

REFERENCES:

1. Scott, R. M. Basic concepts of Industrial Hygiene, Lewis Publishers, New York, 1997.
2. Peterson, R. D., and Cohen, J. M. the complete (vide to OSHA Compliance, Lewis Publishers, New York, 1997.
3. Diberardins, L. J., Handbook of Occupational Safety and Health, John Willey, New York, 1998.
4. Park, J. E. and Park, Preventive and Social Medicine.
5. John Lenihan and William, W. Felcher (ED) 1976, Health and Environment and man series, Academic press, New York.

CORE PRACTICAL IV

METHODOLOGY IN ENVIRONMENTAL ANALYSIS AND MANAGEMENT

Water analysis:

1. Estimation of Turbidity
2. Estimation of pH
3. Estimation of Chloride
4. Estimation of Total dissolved solids-
5. Estimation of Dissolved oxygen-
6. Estimation of Carbonates-bicarbonates-
7. Estimation of Total Hardness
8. Estimation of Phosphate
9. Air Sampling (High volume air sampler) - Demonstration
10. Pollution Indicators

SKILL BASED SUBJECT

PAPER - 4

ENVIRONMENTAL ENERGY AUDIT

UNIT – I

Energy resources: Fundamentals of Electricity; production, transmission, distribution and T & D loses; electric energy consumption seasonal influence, calculation of peak and off hours. Energy performance; subscribed power, maximal reached power; reactive energy consumption**.**

UNIT – II

Energy management strategies: Functions of Energy manager; qualities of energy manager, Tools of energy management. Energy audit, definition, types and benefits.

UNIT – III

Energy auditing – types, components, steps and methodology – for preliminary and detailed audit; stages of energy auditing: interview with key personal, facility tour, document review, facility inspection, utility analysis.

UNIT – IV

Energy consumption and efficiency rating; performance improvement. Energy conservation measures (ECMS) and opportunities, technical and economic analysis, documentation of findings/reporting. Review recommendation with facility findings. Corrective action procedure. Ten important checklists for auditing**.**

UNIT – V

Scope of auditing. Energy audit instruments and working principle; qualities of energy auditor, fuel and energy substitution – yard stick. Energy auditing case studies: agriculture, agro processing industries; Power industry: domestic sector, corporate sector, commercial buildings.

REFERENCES:

1. Wayne C. turner. Energy management handbook. John Wiley and Sons.
2. Doty, S. 2011. Commercial Energy Auditing Reference Handbook. Fairmont Press Inc. Taylor & Francis Ltd.
3. www.eeca.govtz.nz
4. www.energyusernews.com/

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