

Table 1. Scheme of Instruction and Evaluation

Semester	Course Code	Study component	Instructional hours / week		Credits	Evaluation		Total Credits
			Theory	Practical		CE	ESE	
I	EN 1111.3	English I	4	-	3	20%	80%	18
	1111.3	Additional Language I	3	-	3	20%	80%	
	EE 1121	Foundation Course I	3	-	3	20%	80%	
	EE 1131	Complementary Course I	3	-	3	20%	80%	
	EE 1132	Complementary Course Practical	-	2	-	20%	80%	
	EE 1141	Core Course I	3	-	3	20%	80%	
	EE 1142	Core Course Practical		2		20%	80%	
	EE 1171	Vocational Course I	3	-	3	20%	80%	
	EE 1172	Vocational Course Practical	-	2	-	20%	80%	
II	EN 1211.3	English II	4	-	3	20%	80%	24
	1211.3	Additional Language II	3	-	3	20%	80%	
	EE 1221	Foundation Course II	2	-	2	20%	80%	
	EE 1231	Complementary Course II	3	-	3	20%	80%	
	EE 1232	Complementary Course Practical		2	2	20%	80%	
	EE 1241	Core Course II	4	-	4	20%	80%	
	EE 1242	Core Course practical		2	2			
	EE 1271	Vocational Course II	3	-	3	20%	80%	
	EE 1272	Vocational Course Practical	-	2	2	20%	80%	
III	EN 1311.3	English III	5	-	3	20%	80%	19
	EE 1331	Complementary Course III	3	-	3	20%	80%	
	EE 1332	Complementary Course Practical	-	2	-	20%	80%	
	EE 1341	Core Course III	3	-	3	20%	80%	
	EE 1342	Core Course IV	3	-	3	20%	80%	
	EE 1343	Core Course Practical	-	2	-	20%	80%	
	EE 1371	Vocational Course III	4	-	4	20%	80%	
	EE 1372	Vocational Course IV	3	-	3	20%	80%	
	EE 1372	Vocational Course Practical	-	2	-	20%	80%	
IV	EN 1411.3	English IV	5	-	3	20%	80%	22
	EE 1431	Complementary Course IV	3	-	3	20%	80%	
	EE 1432	Complementary Course Practical		2	2	20%	80%	
	EE 1441	Core Course V	5	-	4	20%	80%	
	EE 1442	Core Course VI	2	-	2	20%	80%	
	EE 1443	Core Course Practical	-	2	2	20%	80%	
	EE 1471	Vocational Course V	4	-	4	20%	80%	
	EE 1472	Vocational Course Practical	-	2	2	20%	80%	

Semester	Course Code	Study component	Instructional hours / week		Credits	Evaluation		Total Credits
			Theory	Practical		CE	ESE	
V	EE 1541	Core Course VII	4	-	4	20%	80%	16
	EE 1542	Core Course VIII	4	-	4	20%	80%	
	EE 1543	Core Course Practical	-	5	-	20%	80%	
	EE 1551	Open Course I	2	-	2	20%	80%	
	EE 1571	Vocational Course VI	3	-	3	20%	80%	
	EE 1572	Vocational Course VII	3	-	3	20%	80%	
	EE 1572	Vocational Course Practical	-	4	-	20%	80%	
VI	EE 1641	Core Course IX	3	-	3	20%	80%	21
	EE 1642	Core Course III	2	-	2	20%	80%	
	EE 1643	Core Course Practical	-	4	2	20%	80%	
	EE 1661.1 EE 1661.2 EE 1661.3 EE 1661.4	Elective Course I	2	-	2	20%	80%	
	EE 1671	Vocational Course VIII	3	-	3	20%	80%	
	EE 1671	Vocational Course IX	3	-	3	20%	80%	
	EE 1673	Vocational Course Practical	-	4	2	20%	80%	
	EE 1644	Project and Factory Visit	4	-	4	20%	80%	

Table showing the credits for the programme

First language-English

Semester	Working hours/week	No of Courses	No of Credits
Sem 1	4	1	3
Sem 2	4	1	3
Sem 3	5	1	3
Sem 4	5	1	3

Total No. of credits = 12

Additional language (Hindi/Malayalam)

Semester	Working/ hours	No of Courses	No of Credits
Sem 1	3	1	3
Sem2	3	1	3

Total No. of credits = 6

Complementary course (Chemistry)

Semester	Working hours/week Theory Practicals	Total Hours	No of Courses	No of credits
Sem 1	3 2+2#	7	1	3
Sem 2	3 2+2#	7	1	3
Sem 3	3 2+2#	7	1	3
Sem 4	3 2+2#	7	1+1*	3 + 4 *

The additional 2 hrs as per university regulation of work load for practicals if number of students exceeds 15 in a batch

*Practical Examinations will be conducted only on even semester by the university

Total No of Credits 12+4=16

Foundation Course

Semester	Working hours/week Theory Practicals	Total Hours	No of Courses	No of credits
Sem 1	3	3	1	3
Sem 2	2 + 2 # *	6	1+1	2

2 hrs as per university regulation of work load for practicals; Total No of Credits = 5

*Practical examination for foundation course

Core Course (Environmental science)

Semester	Theory Hrs/ Week	Practical Hrs/week	Total Hrs	No of course	No of credits
Sem1	3	2 + 2#	7	1	3
Sem 2	4		4	1	4
Sem 3	6	2+2#	10	2	6
Sem 4	7	2+2#	11	2+1**	6+4**
Sem 5	8	4+4#	15	2	8
Open	3		3	1	2
Sem 6	5	4+4#	13	2+1***	5+4***
Elective	3		3	1	2

#2 hrs as per university regulation of work load for practicals

* Practical examination for foundation course and core course are conducted together as part I & II and the credit is included with core course of 2 credits

At the end of 4th semester; * At the end of 6th semester

*Practical Exam will be conducted by the university;

Total No of credits 32+6=38

Vocational Course (Water Management)

Semester	Theory Hrs/ Week	Practical Hrs/week	Total Hrs	No of course	No of credits
Sem1	3	2+2#	7	1	3
Sem2	3	2+2#	7	1+1	3+2=5*
Sem3	7	2+2#	11	2	4+3=7
Sem4	4	2+2#	8	1+1*	4+2=6*
Sem5	6	4+4#+4+4#	22	2	3+3=6
Sem6	6	4+4#	14	2+1 *	3+3+2=8*
Project		4+4#	8	1	4

#2 hrs as per university regulation of work load for practicals

Practical Exam will be conducted by the university;

Total No of Credits 27+8=35

B.Sc Environmental Sciences & Environment and Water Management

Six semesters; One semester-18 weeks

Total No of Courses : 43

Sl.No	Study component	No.of courses	Total credit
1	Language English	4	12
2	Additional Lan(Hin/Mal)	2	6
3	Foundation course	2	5
4	Complementary course	6	16
5	Core course	13	38
6	Vocational course	12	35
7	Open Course	1	2
8	Elective courses	1	2
9	Dissertation	1	4
10	Total	43	120

Total No of Credits = 12+6+16+5+38+35+2+2+4=120

Semester 1

Semester	Study component	Title of course	Instructional Hrs
EN1111.3	English I	-	4x18=72
1111.3	Additional Language (Hin/Mal) I	-	3x18=54
EE1121	Foundation Course I	1. Computer Basics and Informatics	3x18=54
EE1141	Core Course I	1. Research Methodology and Perspectives of Science	3x18=54
EE1142	Core Course Practical	2. Environmental Science lab	2x18=36
EE1171	Vocational Course I	1. Water Resources and Fluid Mechanics	3x18= 54
EE1172	Vocational course Practical	2. Water Management Lab	2x18=36
EE1131	Complementary Course I	1. Theoretical Inorganic chemistry	3x18=54
EE1132	Complementary Course Practical	2. Chemistry lab	2x18=36

Eng-4; SL-3; FC-3; CoreC-5; Vo C-5; Comp C-5; Total=25 Instructional Hrs/week

Semester II

Semester	Study component	Title of course	Instructional Hrs
EE1211.3	English II	-	4x18=72
EE1211.3	Additional Language (Hin/Mal) II	-	3x18=54
EE1221	Foundation Course	1. Computer Application for Biostatistics	2x18=36
EE1241	Core Course II	1. Environmental studies	4 x 18=72
EE 1242	Core Course practical	Environmental Science lab	2 x 18 = 36
EE1271	Vocational Course II	1. Water Resources management	3x18=54
EE1272	Vocational Course Practical	2. Water Management lab	2x18=36
EE1231	Complementary course II	1. Organic and Environmental Chemistry	3x18=54
EE1232	Complementary course Practical	2. Chemistry lab	2x18=36

Eng-4; SL-3; FC-2; Core C- 6; Vo C-5; Comp C- 5; Total=25 Instructional Hrs/week

Semester III

Semester	Study component	Title of course	Instructional Hrs
EE1311.1	English III	-	3x18=54
EE1341	Core Course III	1. Natural Resources and Conservation	3x18=54
EE1342	Core Course IV	2 Environmental Management	3x18=54
EE1343	Core Course Practical	3. Environmental Science lab	2x18=36
EE1371	Vocational III	1. Hydrology	4x18=72

EE1372	Vocational IV	2. Water Quality Parameters and Assessment	3x18=54
EE1373	Vocational Practical	3. Water Management lab	2x18=36
EE1331	Complementary III	1. Analytical Chemistry and Biomolecules	3x18=54
EE1332	Complementary Practical	2. Chemistry lab	2x18=36

Eng-3; Core C-8; Vo C-9; Comp C-5; Total =25 Instructional Hrs/week

Semester 1V

Semester	Study component	Title of course	Instructional Hrs
EE1411.3	1. English IV	-	5x18=90
EE1441	Core Course V	1. Environmental Biotechnology & Microbiology	5x18=90
EE1442	Core Course VI	2. Biophysics, Biostatistics and Computer Application	2x18=36
EE1443	Core Course Practical	3. Environmental Science lab	2x18=36
EE1471	Vocational V	1. Water Quality Management	4x18=72
EE1473	Vocational Practical	3. Water Management lab	2x18=36
EE1431	Complementary IV	1. Physical chemistry	3x18=54
EE1432	Complementary Practical	2. Chemistry lab	2x18=36

Eng-5; Core C-9; Vo C-6; Comp C-5; Total =25 Instructional Hrs/week

Semester V

Semester	Study component	Title of course	Instructional Hrs
EE1541	Core Course VII	1. Environmental Geology and Mineralogy	4x18=72
EE1542	Core course VIII	2. Natural Hazards and Meteorology	4x18=72
EE1543	Core Course Practicals	3. Environmental Science lab	5x18=90
EE1571	Vocational Course VI	1. Water pollution	3x18=54
EE1572	Vocational Course VII	2. Water quality Management- II	3x18=54
EE1573	Vocational course Practical	3. Water Management lab	4x18=72
EE1551	Open course	1. Solid Waste Management	2x18=36

Core C-13; Vo C-10; Open C-2; Total =25 Instructional Hrs/week

Semester VI

Semester	Study component	Title of course	Instructional Hrs
EE1641	Core course IX	1. Environmental Pollution and Control Measures-I	3x18=54

EE1642	Core course X	2.Environmental Pollution and Control Measures-II	2x18=36
EE1643	Core Course Practical	3.Environmental Science lab	4x18=72
EE1671	Vocational Course VIII	1.Water Analysis	3x18=54
EE1672	Vocational Course IX	2Watershed Management	3x18=54
EE1673	Vocational Course practical	3. Water Management lab	4x18=72
EE1661.1 EE1641.2 EE1641.3 EE1641.4	4.Elective	a.Rain water Harvesting b.Environmental Aspects of Estuarine System c. Disaster Management d.Elementary Concepts in GIS & GPS	2x18=36
EE1644	Project	Environmental Science/ Water Management	4 x 18 = 72

Core C-9; Vo C-10; Project -4; Elective-2; Total = 25 Instructional Hrs/week

CORE COURSES

- I. Research Methodology & Perspectives of Science
- II. Environmental Studies
- III. (1) Natural Resources and Conservation
(2) Environmental Management
- IV. (1) Environmental Biotechnology and Microbiology
(2) Biophysics, Biostatistics and Computer Application
- V (1) Environmental Geology and Mineralogy
(2) Natural Hazards and Meteorology
- VI. (1) Environmental Pollution and Control Measures I
(2) Environmental Pollution and Control Measures II

VOCATIONAL COURSES

- I. Water Resources and Fluid Mechanics
- II. Water Resources Management
- III (1) Hydrology
(2) Water Quality Parameters and Assessment
- IV Water Quality Management -I
- V (1) Water Pollution
(2) Water Quality Management-II

Semester 5 (Open Course) Solid Waste Management

- VI (1) Water Analysis
(2) Watershed Management

Semester 6 (Elective Course)

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|--------------------------|--|
| a. Rain Water Harvesting | b. Environmental Aspects of Estuarine System |
| c. Disaster Management | d. Elementary Concepts in GIS & GPS |

COMPLEMENTARY COURSES

- I. Theoretical Inorganic Chemistry
- II. Organic and Environmental Chemistry
- III. Analytical Chemistry and Biomolecules
- IV. Physical Chemistry

FOUNDATION COURSE

- I. Computer Basics & Informatics
- II. Computer Application for Biostatistics

FOUNDATION COURSE

- I. **Computer Basics & Informatics** 54 hrs

Computer

History and development of computers - basic knowledge of computer systems - softwares and hardwares - free softwares - M.S Word, Excel, Power point.

Computer ethics - software piracy – internet. Piracy – privacy- computer security; computer crimes - hacking and cracking. 9 hrs

Internet - managing bodies of the internet - Internet Society - Internet Service Provider - Internet application software. 9 hrs

Overview of Information Technology

Features of the modern personal computer and peripherals - Computer network. 9 hrs

Knowledge Skills

Data information and knowledge - Internet as knowledge repository - Introduction to use of IT in teaching and learning. Educational softwares. INFLIBNET - academic services. 9 hrs

Social Informatics

IT and society - overview of it's application in medicine, health care, environmental studies-defence, crime detection, communication. 9 hrs

Applications of IT in weather forecasting, education, film and media - virtual reality. 9 hrs

References

1. Cultural Boundaries of Science. T.F.Gieryn, University of Chicago press, 1999 .
2. Alexis Leon & Mathew Leons, Computers Today, Leon Vikas.
3. Alexis Leon & Mathew Leons, Computers Today, Leon Vikas. Fundamentals of Information Technology. ISBN 08125907890
4. Learning Computer Fundamentals, Khanna Book Publishers, ISBN, 818752252b
5. John Ray 10 Minute Guide to Linnx PHI, ISBN 81-203-1549-9.

- II **Computer Application for Biostatistics** 36 hrs

Computer applications - preliminary concepts - sampling, sampling designs - sampling techniques - sample random – systematic sampling data - data presentation – numeric – alphabetic – alphanumeric.

9 hrs

Collection and representation of data - collection and classification tabulation of data.

Graphical representation of data - methods of preparation of graph - Frequency curve relative frequency map - cumulative frequency map - relative frequency map or ogive. Dot diagram -significance of graphic representation - limitations of graphic representation. 9 hrs

Measures of central tendencies - mathematical average, average of position - measures of dispersion - range-mean deviation - standard deviation - distribution patterns. 9 hrs

Types of variability - experimental variation - biological variability, real variability - experimental variability, error, subjective, objective instrumental and sampling error. 9 hrs

References

1. Elements of Biostatistics -S.Prasad. ISBN 81-7133-613-2 Title code bc-33 First edition -2003 Rastogi publications, Gangotri, Shivagiroad-Meerut 250 002.
2. Methods in Biostatistics for Medical students & research works-V.K Mahajan. Jaypee Brothers Medical brothers Pvt Ltd, New Delhi- 6th edition.
3. Introduction to Biostatistics. Pranab Kumar Banerjee and S.Chand. ISBN81-219-2329-8. First edition 2004. Rajendra Raveendra Printers Pvt. Ltd., Ram Nagar, New Delhi 110 055.

FOUNDATION COURSE - PRACTICALS

Semester II Computer Application for Biostatistics

1. Create a power point presentation of wild life population.
2. Graphical representation - Bar, Pie charts of flora and fauna.
3. Plotting straight lines
4. Determination of Central tendencies

CORE COURSE

SEMESTER I Research Methodology & Perspectives of Science

54 hrs

Introduction to research Methodology

Research fundamentals and terminologies. Introduction - scientific method - meaning of research - comparison of scientific method & non scientific method - objectives of research-research methodology - types of research. 12 hrs

Defining research problems - formulation of the problem - developing the research plan. Research design – design – experimentation – evaluation - validity of experiment. 10 hrs

Statistical analysis and interpretation of data. Report writing and presentation. Writing and formatting of reports - report presentation. 8 hrs

Perspective of science

Design of an experiment – experimentation - data collection - interpretation and deduction repeatability and replication - documentation of experiments - record keeping - planning of experiment – designs - instrumental requirements - types of instrumentation - accuracy and precision. 14 hrs

Data handling in science

Significance of statistical tools in data interpretation - errors and inaccuracies. Ethics in science -scientific information - digital sources. 10 hrs

References

1. The Glen: What everyone should know about Science. H.Collins and T.Pinch, Cambridge University press, 1993.
2. Cultural Boundaries of Science. T.F.Gieryn, University of Chicago press, 1999
3. Elements of Biostatistics. S.Prasad. ISBN 81-7133-613-2. Title code bc-33 First edition -2003. Rastogi publications, Gangotri, Shivagiroad- Meerut 250 002.
4. Introduction to Biostatitics. Pranab Kumar Banerjee and S.Chand. ISBN81-219-2329-8, First edition 2004. Rajendra Raveendra Printers Pvt. Ltd. Ram Nagar, New Delhi.
5. Research methodology. Dipak Kumar. Bhattacharya Excel Books, A-5, Naraina, Phase-1, New Delhi.

SEMESTER I Core course (Practicals)

1. Sampling methods - Plant or animal community on land.
2. Population censusing methods - Total count, sampling.
3. Estimation of beetle in wheat flour.
4. Study of common flora and fauna.

II Environmental Studies

72 Hours

- Unit 1 : Multidisciplinary nature of environmental studies; Definition, scope and importance, need for public awareness. (2 hrs)
- Unit 2 : Natural Resources : Renewable and non-renewable resources : Natural resources and associated problems. a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources : World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. (12 hrs)
- Unit 3 : Ecosystems : Concept of an ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of the following ecosystems :-
- a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem
 - d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) (10 hrs)
- Unit 4 : Biodiversity and its conservation : Introduction – Definition : genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation; Hot-spots of biodiversity; Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity. (12 hrs)
- Unit 5 : Environmental Pollution : Definition, cause, effects and control measures of :- a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution e. Noise pollution, f. Thermal pollution, g.

Nuclear hazards; Solid waste Management : Causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies.; Disaster management : floods, earthquake, cyclone and landslides. (12 hrs)

Unit 6 : Social Issues and the Environment : From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problems and concerns. Case Studies; Environmental ethics : Issues and possible solutions; Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies; Wasteland reclamation; Consumerism and waste products; Environment Protection Act.; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness. (12 hrs)

Unit 7 : Human Population and the Environment : Population growth, variation among nations; Population explosion – Family Welfare Programme; Environment and human health; Human Rights; Value Education; HIV/AIDS; Women and Child Welfare; Role of Information Technology in Environment and human health; Case Studies. (7 hrs)

Unit 8 : Field work : Visit to a local area to document environmental assets river/ forest/grassland/hill/ mountain; Visit to a local polluted site-Urban/Rural/Industrial/Agricultural; Study of common plants, insects, birds; Study of simple ecosystems-pond, river, hill slopes, etc. (Field work Equal to 5 lecture hours). (5 hrs)

REFERENCES

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad –380 013, India, Email:mapin@icenet.net
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clarendon Press Oxford
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
6. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
7. Down to Earth, Centre for Science and Environment
8. Gleick, H.P. 1993. Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
9. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay
10. Heywood, V.H & Weston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
11. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
12. Mckinney, M.L. & School, R.M. 1996. Environmental Science Systems & Solutions, Web enhanced edition. 639p.
13. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
14. Miller T.G Jr. Environmental Science, Wadsworth Publishing Co. (TB)
15. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
16. Rao M.N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
17. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
18. Survey of the Environment, The Hindu (M)

19. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science
20. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)
21. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
22. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

SEMESTER II Core course (Practicals)

1. Identification of flora and fauna – terrestrial, marine and freshwater ecosystems
2. Estimation of primary productivity – light and dark bottle method
3. Community study : quadrat and line transect method
4. Construction of food chain/ food web : terrestrial and aquatic ecosystems

III Paper (1) Natural Resources and Conservation

54 hours

Natural resources- definition and classification-Natural resources with reference to India. Renewable and non-renewable resources - Exhaustible and non- exhaustible resources; Mineral resources – distribution –production-coal fossil fuel 10 hrs

Biotic resources-forest and wild life – Biodiversity-hot spots in India-threat to biodiversity. *In situ & Exsitu* conservation. Soil and Land Land use pattern - Green revolution; River systems-climate and climatic regions of India. Seasons - onset and retreat of Monsoon –Drought – flood; Flood control programme. 12 hrs

Energy resources- Energy crises-Conventional and non -conventional energy -Types of energy .Fossile fuel –Hydel – Thermal – Nuclear – Solar – Wind – Biomass-Growing energy needs-Alternate energy sources. 10 hrs

Conservation- Minerals – soil- Forest- Wild life -Biotic resources – Fuel - Energy 10 hrs

Man and population, density, distribution-growth trends-sex ratio-age, Population explosion. 12 hrs

References

1. Economic and commercial geography of India T.C Sharma Coutinho, Vikas publishers- New Delhi
2. A Text book of Environmental sciences-PurohitShamiAgrawal-student Edition
3. India – ComprehensiveGeography.D.R.Khuller-Kalyani Publishers.
4. A.Text Book of Environmental studies.E.Barucha.University Press,Hydrabad.

SEM III Practical

1. Measuring rainfall and calculation of normal rainfall.
2. Recording of maximum -minimum temperature
3. Recording of humidity.
4. Preparing a field map using prismatic compass.

SEM III Paper (2). Environmental Management

54 hrs

Definition - Basic principles of Environmental Management. Environment Impact Assessment-Definition and aim, Principles and Concepts of EIA- EIA assessment methodologies - few case studies. 9 hrs

Concept of Sustainable Development - UN and International conferences - Rio summit Johannesburg conference on sustainable development; Copenhagen summit. 9 hrs

Environment laws and policies-Historical background of Environment laws - Environment Protection Act, Forest Conservation Act, The Wildlife protection Act, The Air Act, Water Act. 9 hrs

National Environment policies Public Interest Litigation (PIL)-List of cases like M.C.Mehtha vs Union Government of India. 9 hrs

Environment friendly products - pollution abatement technologies; concept of environmental planning - city planning. 9 hrs

Introduction to Environmental Economics.- environmental issues. 9 hrs

References

1. Environmental laws of India. An introduction. CPR Environmental Education Centre Chennai, 2000.
2. A text book on Environmental Studies. D.K.Asthana and Meera Athana. S.Chand and Co.
3. Ecology and Sustainable Development. P.S.Ramakrishnan. NBS New Delhi, 2001.
4. Environmental laws. Gurudip Singh. Macmillan India ltd.
5. Introductory Text of Environmental policies and laws. V.K.Garg, M.S Bishnoi, C.P Malik Kalyani Publishers, New Delhi.
6. Environmental Laws, Dharmendra.S.Sengar, Prentice Hall of India Pvt.ltd, Dew Delhi, 2000.

SEMESTER III Practicals

1. A Collection and submission of 5 Eco-friendly products.
2. A report of visit to a factory where Pollution abatement technology is implemented.
3. A report on environmental law case study in India.
4. A case study of EIA

SEM IV Paper 1 - Environmental Biotechnology and Microbiology (90 hours)

Biotechnology - definitions. Scope of biotechnology in agriculture, food production and nutrition. Impact of biotechnology on sustainability of the environment. Ethical and social impacts of biotechnology. Genetic Engineering - Brief study of gene cloning in prokaryotes. 12 hrs

Molecular tools for genetic engineering. Enzymes: Restriction endonucleases. Role of restriction endonucleases in genetic engineering. Recognition sequences, cleavage patterns. Mention of some common RE's - Eco RI, Bam I. Mention of the role of DNA ligases, Terminal transferase in genetic engineering. 12 hrs

Vectors: Role of vectors in GE. Mention of common vectors such as plasmids, bacteriophages, cosmids, artificial chromosome vectors like HAC, YAC, BAC. Host cells: Role of host cells in GE. Mention of prokaryotic hosts - *E coli*, *Bacillus subtilis*. Methods of gene transfer: Mention of transformation, conjugation, electroporation, lipofection, direct transfer. 12 hrs

Salient features of different microbial groups and their current classification - algae, fungi, bacteria, viruses, protozoa, mycoplasma and rickettsia. Microbial nutrition: Photoautotrophy, chemoautotrophy, heterotrophy. Interactions between microorganisms: commensalism, mutualism, parasitism and ammensalism. 12 hrs

Microbial interactions with plants: mycorrhiza, rhizobium, actinomycetes and their interactions with legume associations and rhizosphere. Microorganisms in biomass and energy production: Microbes producing protein - single cell protein. Methane (Biogas or Gobar gas) 12 hrs

Environmental Microbiology - Different fields in environmental microbiology. Microbes and geochemical cycles - Nitrogen cycle, Sulphur cycle, Microorganisms as geochemical agents. 12 hrs

Growth of micro organisms - cell cycle, population growth, batch culture, continuous culture. Mycelial growth. Environmental factors and microbial growth. 9 hrs

Microbes and environmental clean up - Biodegradation. Bioremediation - Need and scope. Environmental applications of bioremediation. Bioremediation technologies. Removal of toxic chemicals. 12 hrs

Epidemiology of microbial diseases of Man - Tuberculosis, Cholera, Hepatitis, AIDS, Histoplasmos, Aspergillosis, Amoebiasis and Malaria. 9 hrs

REFERENCES

1. Ecology & Environment, P.D. Sharma.
2. Environmental Biology & Toxicology, P.D. Sharma.
3. General Microbiology Volume I & II C.B, Power & H.F. Dagainawala. Himalaya Publishing house, New Delhi, 1982.
4. A text book of microbiology. Anathanarayana, S.
5. Microbiology P.D. Sharma, Restegi & Company, Meerut, 1989.
6. An Introduction to Microbiology, R.P. Singh & Kamal Central Book Depot, Allahabad 1989.
7. Ecology and Biology of Soil microorganisms: S.C. Bhandar & L.L. Somani, Agretech Publishing, Udaipur, 1994.
8. A text book of Microbiology. S.S. Purohit. Student edition, Jodhpur. 2004.
9. Biotechnology Applications and Carriers. Meenakshi Munshi, S.K. Sopory, Viva Book Pvt Ltd.
10. Basic Biotechnology. Rev. Fr. Dr. Ignacimuthu, S. J, Tata Mc Graw_Hill Publication Company Ltd.
11. Modern Concepts of Biotechnology. H.D. Kumar, Vikas Publishing House.
12. Biochemistry. U. Sathyanarayana.

SEMESTER IV PRACTICALS Paper -I

1. Demonstration of Sterilisation by dry heat and wet heat (Steam Autoclaving)
2. Culture media preparation using PDA (Potato Dextrose Agar)
3. Growth of *E. Coli* in liquid media.
4. Slides of specimens - Paramecium, Spirogyra, Penicillium, coliform bacteria.

SEMESTER IV Paper (2) Biophysics, Biostatistics and Computer Application 36 hrs

Biophysics

Light observation effect effect-Beer and Lambert's law. Absorption spectrum, Redox potential-Laws of photochemistry. Fluorescence, phosphorescence and other photochemical reaction. 9 hrs

Principle and applications of light and electron microscopy, Spectrophotometry, mass spectrometry Absorption spectroscopy, X-ray analytical methods. 9 hrs

Biostatistics Various sampling methods, Measures of dispersion Test of significance, Chi square test and t-test statistical analysis using computer. 9 hrs

Internet browsing and websites for statistical analysis (Basic idea only). 9 hrs

References

1. Molecular structure and spectroscopy G.Arul Das, Prentice Hall 2007
2. Bio Physics-Principle and Techniques, -2005M.A Subramoniam .MPJ Publishers Chennai.
3. A. Text book of Spectroscopy.Banwell

SEMESTER V Paper (1) Environmental Geology and Mineralogy 72 hrs

Introduction to Geology - Environmental Geology - Definition and scope - Geological agents-Exogenous, and endogenous geological agents. Current views on origin of earth. 12 hrs

The classification of rocks based on their origin; concept of rock cycle; weathering. River as a geological agent; development of river. Rivers in India. 12 hrs

Streams - Drainage basin - Drainage pattern; energy in streams; factors controlling formation of soil; soil profiles. 12 hrs

Glaciers - Types and geological activity - wind -geological activity of wind. Meteorology -elements and factors of climate-influence weather and climate in agriculture; heat island - effect of climate change in ecosystem. 12 hrs

Crystals and minerals - Physical properties of minerals such as colour, streak lustre, hardness and specific gravity. Composition and diagnostic properties of minerals – Quartz, feldspar, talc gypsum, galena, beryl, corundum. 12 hrs

Nature and genetic relationship with igneous rocks-Textures of igneous rocks Megascopic features of the following rock types - granite, syenite, gabbro, basalt. 12 hrs

A brief study of the origin of sediments and sediment rocks. Feature of the following sedimentary rocks - sand stones. 12 hrs

References

1. Text book of Engineering, Geology,N. Chenna Kesaulu 1993 JNTU College of Engineering, Macmillan India limited.
2. Atmospheric Science and Environment, G.N.Ghosh. ISBN 81-7764-043-7-(C) 2000, Allied publishers Ltd.
3. A text book of Geology. Mukergee,P.K, 1986.
4. Engineering & General Geology, Parbinsingh,S.K.Katariah & sons, Gurunank market New Delhi.

SEMESTER V PRACTICALS Paper -II

1. Identification of common minerals & rocks
2. Identification of soil types - red soil, alluvial soil, black soil
3. Determination of soil moisture content.
4. Determination of soil pH
5. Determination of conductivity.
6. Estimation of organic carbon of soil

SEMESTER V Paper (2) Natural Hazards and Meteorology 72 hrs

Basic concept and definition of natural hazard and disaster - earth quake - distribution and causes; volcanoes - types and causes of volcanic eruptions. 12 hrs

Introduction to landslides, (Tsunami), cyclones, floods, hurricane, tornadoes, drought, fire; Causes, mitigation and management. 12 hrs

Anthropogenic disasters : chemical, industrial hazards, nuclear power plants, occupational hazards; hazards due to dam break. Mitigation measures. 12 hrs

Differences between natural disaster and artificial disasters. Environmental health hazard and risk management; Risk identification and assessment – prevention and mitigation. 12 hrs

Meteorology - elementary concept of climate, weather and climate. Clouds – types and classification; wind – forces affecting wind; types of wind and measurement; precipitation – measurement of precipitation; micrometeorology 12 hrs

Climate change in agriculture; urban climatology; drivers of climate change – green house gases; effect of climate change on ecosystems, factors affecting climate. 12 hrs

References

1. A text book of Geology -Mukergee ,P.K 1986
2. Rutley's elements of Minerology CBS.Publishers.New Delhi
3. Physical geography.StablerA.N.and Strahler,A.,H.1987
4. Principles of Petrology,TyrrelG.W.1948

SEMESTER VI. Paper (1) Environmental Pollution and Control Measures–I (54 hrs)

Air pollution - basic definitions and requirements - structure of atmosphere - composition of air, primary and secondary pollutants - unit for quantification of air pollution. Classification of air pollutants. 12 hrs

Automobiles exhaust - Emission standards - CO_x, NO_x, SO_x. Indoor air pollution. Effect of pollutants on plants and human beings. 9 hrs

From Factories - hydrocarbons, polychlorinated hydrocarbons; photochemical smog. 6 hrs

Control of air pollution - from factories-Automobile Exhaust-Automobile emission standards- Specific emission standards; Bharath Stages -I,II,III. Measures to check Industrial pollution. 9 hrs

Sources of correction - Control of particulate - removal of particulate matter. Control strategies - control of specific gaseous pollutants - Air Quality standards. 6 hrs

Hazardous Wastes – definition; identification & classification - Generation of hazardous wastes - Management of hazardous wastes. Health and environmental effects of hazardous wastes-treatment methods. 12 hrs

References

1. A text book on Environmental Pollution and Control, Dr .H S. Bhatia, Galgotia Publications Private Ltd-5, Ansari road, Darya Ganj, Delhi-110 002.
2. Industrial Pollution, V.P.Kudesia, Pragati Prakashan, Meerut 250 001.
3. Air pollution, V.P.Kudesia, Pragathi Prakashan Meerut 250 001.

SEMESTER VI Paper (2) Environmental Pollution and Control Measures -II 36 hrs

Parameters of water pollution - standards of aquatic life. Classification of industrial wastes. 6 hrs

Land and soil pollution - Disposal on land - pesticides pollution- control of soil pollution. 6 hrs

Noise pollution – definition; measurement - decibels; effect of noise pollution on people; traffic noise pollution; industrial noise pollution. 6 hrs

Railway noise; aircraft noise; reduction of noise; absorption of sound. Control of noise pollution. 6 hrs

Radioactive pollution - Kinds of radiation; nuclear reactions; natural sources of radioactive pollution; anthropogenic sources of radiation. Radioactive waste; biological effects of radiation pollution; dangers from nuclear plants. 6 hrs

Control from radiation - methods of control; minimizing X-ray hazard - Hazards of Radioactive pollution - Preventive measures from radiation. 6 hrs

References

1. A text book on Environmental pollution and Control. Dr .H S. Bhatia. Galgotia Publications private limited-5,Ansari road, Darya Ganj, Delhi-110 002.
2. Industrial Pollution. V.P.Kudesia-Pragati Prakashan, Meerut 250 001.
3. Air pollution. V.P.Kudesia, Pragathi Prakasan Meerut 250 001.

SEMESTER VI PRACTICALS Paper -I

INSTRUMENTATION (Demonstration)

- | | |
|-----------------------|----------------------|
| 1. pH meter | 4. Colorimeter |
| 2. Conductivity meter | 5. Spectrophotometer |
| 3. Turbidity meter | |

SEMESTER VI PRACTICALS Paper -II

1. Determination of COD
2. Analysis of anion mixture solution (2 Anions)among the following – Carbonate, sulphide, Thiosulphate, Oxalate, Chloride, Nitrate, Flouride, Sulphate, Phosphate
3. Thin layer Chromatographic separation of plant pigments.

Semester 6 (Elective)

- | | |
|---|-------------|
| a. Rain water Harvesting | 3x18=54 hrs |
| b . Environmental Aspects of Estuarine System | |
| c. Disaster management | |
| d. Elementary concepts in GIS & GPS | |

Semester 5 (Open) Solid Waste management

54 hrs

Solid wastes and its characteristics; classification of solid waste – source; factors affecting quality & quantity. Physical and chemical characteristics - collection & transportation. 9 hrs

Solid wastes from households, institutions, commercial establishment, public amenities; demolition sites; construction sites; mining & quarrying; sewage treatment plants. Types of solid wastes – municipal; agriculture; biomedical; hazardous; radioactive wastes. 9 hrs

Waste Management - global perspective - source reduction - Reuse and recycling. Disposal techniques - composting; principles of composting; factors affecting composting. Types of composting - Windrow layout and management. 9 hrs

Methane recovery; sanitary landfill - advantages and disadvantages of sanitary landfill. Methods of landfill. Incineration - types of incinerators - reactions involved - advantages and disadvantages of incineration. 9 hrs

Estimation of moisture content; determination of combustible matter; determination of calorific value; reactions involved. Functional elements of solid waste management. Disposal system with or without recoveries. 9 hrs

Summary of method of collection - transfer station; Vehicle and equipment for secondary collection. Ethical aspects of waste management; Public participation Law provisions. 9 hrs

References

A text book on Environmental pollution and Control. Dr .H S. Bhatia, Galgotia Publications private limited-5, Ansari road, Darya Ganj, Delhi-110 002.

Semester 6 (Elective)

a. Rain water Harvesting 36 hrs

Rain water harvesting- Rainwater collection for drinking purpose; domestic rain water collection- community rain water collection. 6 hrs

Artificial recharge; methods of artificial recharge; roof water harvesting-surface water harvesting; dug cum borewells. 6 hrs

Mini artificial aquifer systems; borewell and hand pumps; artificial recharge in roads and colonies. Recycling and treating- methodology land use planning in watershed. 6 hrs

Rain water harvesting for sustainable development - water related sustainability issues in cities-Depletion of ground water table- concept of zero run off. Urban RWH practices. 6 hrs

The importance of watershed management in Kerala - Rain water harvesting in Institutional buildings. 6 hrs

Legal provisions in rain water harvesting in India and Kerala. 6 hrs

References

1. A.Keldho .T.I Sustainable watershed management strategies in semi arid regions of India .II Bombay email.eldho@civiliitb.ac.in.
2. KRG Rainwater Harvesting Foundation.

Semester 6 (Elective) 36 hrs

b .Environmental Aspects of Estuarine System

The Estuary- definition - Physical features- salinity, temperature, circulation and mixing processes- Major and minor elements- chemical speciation in estuarine waters- Suspended matter in estuaries- adsorption and desorption processes- Sediment transport and sedimentation- Sediment- water interaction and the geochemistry of interstitial waters. 12 hrs

Nutrients, dissolved gases, and general biogeochemistry in estuaries- Biotic aspects of the chemistry of estuaries - Carbon dioxide - calcium carbonate system in estuaries. 12 hrs

Inorganic pollutants, particularly heavy metals in estuaries - Chlorinated hydrocarbons in estuaries- Oil pollution of the marine environment - with an emphasis on estuarine studies - Recovery and decontamination of estuaries. 12 hrs

References

1. Chemistry and Biogeochemistry of Estuaries. Edited by Eric Olausson and Ingemar Cato- John Wiley and Sons - New York.

2. Estuaries: monitoring and modeling the physical system. By Jack Hardisty. Blackwell Publishing. 350 main street malden MA 02148-5020, USA
3. Biogeochemistry of Estuaries, Thomas S. Bianchi. Department of Oceanography, Texas A&M University. Oxford University Press, 2007
4. Practical handbook of estuarine and marine pollution.

By Michael J. Kennish CRC press marine science series (For Oil Pollution and halogenated hydrocarbons)

Semester 6 (Elective)

d. Elementary concepts in GIS & GPS 36 hrs

Map language – introduction; map as model; spatial elements terminology; classification of maps; map scale; map projection; grouping of map projection; commonly used map projections - Computer in map production; linkage of GIS to Remote Sensing. 9 hrs

Remote sensing; basic principles – Introduction; electromagnetic remote sensing process; nature of electromagnetic radiation. Electromagnetic spectrum; Energy interaction with earth's surface materials. 9 hrs

Fundamentals of GIS - roots of GIS; over view of information system; contribution; disciplines; GIS definition and terminology – Topology – Models - GIS queries - GIS architecture - Components of a GIS. 9 hrs

GIS Work Flow - functional elements of GIS - fundamentals of operations of GIS - theoretical frame work for GIS. GIS categories - level/scales of measurement. Nature of remote sensing-Remote sensing systems - Image display system. 9 hrs.

References

1. A Text book of Remote Sensing and Geographic Information Systems. M. Anji Reddy BS Publications 4-4-309, Giriraj Lane, sulthan Bazar, Hyderabad 500 095.
2. Remote sensing - Models and methods for image processing. Robert A. Schowengerdt-academic Press 525 B street, suite 1900, San Diego, California-92101-4495. USA.

Semester 6 (Elective)

Disaster management 36 hrs

Natural disasters : Introduction to - earthquake, volcanic eruptions, landslides, flash flood (Tsunami), major flood, storm surge, hurricane, tornadoes, drought 9 hrs

Anthropogenic disasters - disasters due to chemical, industrial, nuclear, domestic, dam break. 9 hrs

Pre-disaster, during disaster, post disaster; possibility of disaster - warning system - preparedness relief operations - National, State level, Local level – Agencies; concepts in remote sensing, GIS, GPS – applications. Rehabilitations - immediate, first stage, permanent. 9 hrs

Disaster assessment - casualty assessment; ecosystem damage - assessment. Introduction to disaster management. Management plan - preparedness, vulnerability of disaster, safety measures Role of NGO's - International, National, Regional (UN, Red Cross Army, Paramilitary NCC, NSS) 9 hrs

References

1. R.B. Singh (Ed) Environmental Geography, Heritage Publishers New Delhi, 1990.
2. Savinder Singh Environmental Geography, Prayag Pustak Bhawan, 1997.
3. Kates, B.I. & White, G.F The Environment as Hazards, Oxford, New York, 1978.

4. R.B. Singh (Ed) Disaster Management, Rawat Publication, New Delhi, 2000.
5. H.K. Gupta (Ed) Disaster Management, Universities Press, India, 2003.
6. R.B. Singh, Space Technology for Disaster Mitigation in India (INCED), University of Tokyo, 1994.
7. Dr. Satender , Disaster Management in Hills, Concept Publishing Co., New Delhi, 2003
8. A.S. Arya Action Plan For Earthquake, Disaster, Mitigation. In: V.K. Sharma (Ed) Disaster Management IIPA Publication New Delhi, 1994.
9. R.K. Bhandani An overview on Natural & Manmade Disaster & their Reduction, CSIR, New Delhi.
10. M.C. Gupta Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi, 2001.

VOCATIONAL COURSES

SEMESTER I. Water Resources and Fluid Mechanics 36 hrs

Water as a resource material - multiple uses of water.-consumptive uses- irrigation; Partial consumptive uses-public water supply - Fire demand - Industrial uses - thermal uses. 9 hrs

Nuclear power generation - non consumptive uses - hydropower generation - inland navigation water resources – rivers, ponds, lakes. 9 hrs

Introduction to fluid mechanics - properties of fluids – density – viscosity - surface tension- types of flow - laminar flow - turbulent flow. 9 hrs

Reinhold's Number. Reynold's experiment - flow of water in open channels - pipes, calculation of flow velocity. Head losses – Dary-Weisbach equation; Hazen William's formula; Manning's formula (No derivation). 9 hrs

Reference

1. Ground Water Hydrology. David Keith Todd-Willey International.
2. Water resources Asit.K. Biswas Tata Macgraw Hill publishing company Ltd.
3. Hydrology and water resources. Sharma .RK .Dhanapathrai & Sons.
4. Water Technology N.F Gray 2nd Edition. Butterworth Haimann Publication.
5. A Text book on Fluid Mechanics. R.K.Rajput.S.Chand & Company, New Delhi.

Practical

SEM- I

1. Measurement of rain fall
2. Measurement of Evaporation(Relative Humidity)
3. Measurement of atmospheric temperature
4. Record of humidity

SEMESTER II. Water Resources Management 54 hrs

Water resources : types – surface water, ground water, water availability and uses. Water requirement for various uses - Industrial uses – aquaculture - recreational uses; Irrigational uses - definition of irrigation – necessity – benefits; ill effects - systems. 12 hrs

Lift irrigation – advantages – disadvantages-flow irrigation – Inundation – irrigation. Perennial system of irrigation. Direct irrigation-storage irrigation. 12 hrs

Surface irrigation methods - wild (uncontrolled) flooding method - furrow method - contour farming. Sub surface irrigation method - sprinkler irrigation - drip irrigation. Frequency of irrigation-standard of irrigation water. Irrigation efficiency. 12 hrs

Freshwater shortage; impact of climate on freshwater resources; management and conservation 6 hours

Reference

1. Irrigation Engineering, N.N.Basak.
2. Irrigation Water Power & Water resources Engineering, K.R.Arora Anand Publishers and distributors.

SEMESTER- II Practicals

1. Determination of pH of water sample
2. Determination of Alkalinity of water sample
3. Determination of SPM load of water.
4. Determination of Surface tension by drop weight method.
5. Determination of Surface tension by drop number method
6. Determination of Viscosity of a sample by Ostwalds Viscometer method
7. Determination of Humidity by Psychrometer.

SEMESTER III Paper (1)

Hydrology - I

72 hrs

Surface water hydrology

Hydrology (surface water); definition ; importance. Hydrologic cycle; climatic factors influencing hydraulic cycle – humidity, temperature, radiation, wind. Precipitation - condition for occurrence of precipitation.

9 hrs

Measurement of rainfall - different types of rain gauge; rainfall measurement by radar; errors in measurement; estimation of missing rainfall data; average rainfall over an area. Mean and annual rainfall; measurement of snow fall.

9 hrs

Characteristics of precipitations of India. Evaporators; factors affecting evaporation - Estimation of evaporation - evaporation pan method - Evaporation from soil surface.

9 hrs

Transpiration - Factors affecting infiltration rates. Infiltration rate; infiltration capacity; Infiltration indices; runoff; estimation of runoff; hydrograph; global water balance; water losses-inter basin transfer.

Ground water hydrology

Hydrology - ground water hydrology; occurrence of ground water; different types; Aquitard- Aquifuge - ground water collecting systems – wells.

9 hrs

Types of wells-collection – conveyance and distribution-general study-Ground water movement-Darcy's law (No derivation required); Ground water and well hydraulics.

9 hrs

Ground water and environmental influence-ground water level fluctuation due to stream flow-Evapo-transpiration; urbanization - ground water pollution by municipal, industrial, agriculture, domestic sources.

9 hrs

Saline water intrusion - Investigation of Ground water (Outline study only). Surface and ground water intrusion. Various types of underground sources. Infiltration galleries - Infiltration wells - Spring wells - open wells or dug wells - tube wells - different types. 9 hrs

Reference

1. Hydrology & Water Resources. Sharma R.K .Dhanapath Rai & Sons.
2. Engineering Hydrology Subramonian.K Tata Macgraw Hill publishing company ltd.
- 3.. Irrigation Engineering-N.N.Basak.
4. Water Supply Engineering. Santosh Kumar Garg. Khanna Publishers.
5. Water Resources Asit. K Biswas, Tata Macgraw Hill publishing company ltd.
6. Ground Water Hydrology, David Keeth, Todd-Willy international.
7. Ground Water by Ramakrishnan.

SEMESTER III Paper (2) Water Quality Parameters and Assessment 54 hrs

Water quality parameters - USPHS Scale and WHO scale, sampling; preservation. Water as a solvent. Collection of water sample. Analysis of natural and waste water sampling procedures. Main quality characteristics of water a) Alkalinity b) Hardness c) Total solids. 18 hrs

Physical properties of water- like BP, MP, critical temperature, viscosity, Surface tension, dielectric constant, dipole moment, Heat of vaporization; tolerance limits for trace metals in drinking water (Al, B, Cd, Co, Pb, Mn, Ni, Fe, Zn, Cr, Cu, Mo, Se, Sc). 16 hrs

International standards for Drinking water - pH, BOD, COD, B, As, Cd, Cr, NH₃, Fe, Cl, Hg, Mg, total hardness, pesticides, *E. Coli*, TDS; International standards for drinking water prescribed by WHO. 12 hrs

Water pollution - types of water pollution; Sources of water pollution; Harmful effects of water pollution - Strategies for water pollution control. 8 hrs

Reference

1. Environmental pollution -Management & Control for sustainable development. R. K. Khitoliya S. Chand & Company, Ram Nagar, New Delhi.
2. Laboratory Manual For Environmental Chemistry. Sunitha Hooda, Samanjeet Kaur. S. Chand & Company Ram Nagar New Delhi.
3. Water pollution. B.K.Sharma, Goel publishing House Meerut.

SEMESTER - III Practicals

1. Determination of Chlorine percentage in a sample of bleaching powder.
2. Determination of concentration of chloride ion in a sample of water sample
3. Determination dissolved oxygen in a sample of water.
4. Determination of density of water

SEMESTER IV Paper (2) Water quality Management -I 72 hrs

Water quality requirement and standards for various uses - drinking, industrial, irrigation aquaculture, cooling, recreation. 9hrs

Quality of water from different sources - water quality monitoring, sampling methods for waste water; stream and lake water, sediment. 9 hrs

Sampling equipments :Niskin water sampler, Nansen water sampler, Dussart flask. 9hrs

Water treatment processes; conventional process – sedimentation, coagulation, flocculation, filtration, disinfection. 9 hrs

Physical and chemical methods, UV rays, iodine and bromine – ozone – potassium permanganate – silver and chlorine. Different forms of chlorination. 9 hrs

Water softening - hardness and measurement of hardness - effects of hardness - removal of hardness. 9 hrs

Specific water treatment; removal of iron, manganese, chromium; Desalination. Reverse osmosis; electro dialysis; freezing method; multi flash evaporators 9 hrs

Fluoridation and de-fluoridation. Removal of dissolved gases from water - removal of oil - removal of radiomaterials. 9 hrs

Reference

1. Water supply Engineering B.C.Punmia, Asok Jain & Arun Jain. Lakshmi Publications, New Delhi.
2. Water and Waste Water Technology, Mark.J.Hammer. J Hammer, Printice Hall India Pvt. Ltd.
3. Waste Water Treatment for Pollution Control and Reuse, Tata Macgraw Hill publishing company.
4. Water Technology, N.F Gray Butter Worth, Heimann Oxford.
5. Chemical and Biological Methods of water pollution studies. R.K. Trivedi & R. K. Goel Environmental publication, Karad 1984.
6. Standard Methods for Examination of Water and Waste Water. APHA-Washington DC1985.
7. Ecological Methods for field and Laboratory Investigation, P.Michael. Tata Macgraw Hill publishing Company. New Delhi.

SEMESTER IV Practicals

1. Determination of BOD of a sample of water.
2. Determination of COD of a water sample
3. Determination of TDS in a sample of water.
4. Determination of Salinity in a sample of water
5. Determination of hardness of water

SEMESTER V Paper (1) Water Pollution

54 hrs

Sources of water pollution; physical pollution of water; chemical pollution of water; biological pollution of water. 9 hrs

Common impurities in water; testing of water; physical test; chemical test; bacteriological test. 9 hrs

Standards of drinking water. Water bone diseases; Maintenance of purity of water. Ground water pollution, factors affecting ground water pollution, harmful effects of ground water pollution. 9 hrs

Surface water pollution; Factors affecting surface water pollution - factors affecting nutrient loss in surface water - lake water pollution. 9 hrs

River water pollution - global river water pollution - sea water pollution-marine pollution. Control of pollution in seawater; role of microorganisms in cleanup operation. 9 hrs

Organic pollutants - synthetic detergents; ecofriendly detergents containing enzymes; eutrophication thermal pollution in water; esticide pollutants. 9 hrs

Reference

1. Water pollution. B.K.Sharma, Goel publishing House Meerut.
2. Water supply Engineering B.C.Punmia, Asok Jain & Arun Jain, Lakshmi Publications, New Delhi.

SEMESTER V Paper (2) Water quality management-II**54 hrs**

Quality and characterization of domestic waste water - physical Chemical and Biological Properties of waste water. Determination of COD, BOD. 9 hrs

Natural methods of sewage disposal : Dilution method, Sewage farming method, Self purification theory; Sanitary water management - sanitary waste; Definition-importance, historical back ground. Systems of sewage disposal. Dry conservancy system & water carriage system. 9 hrs

Sewage sickness - primary and secondary treatment - conventional and low cost - advanced waste water treatment including nitrogen and phosphorous removal - miscellaneous treatment of sewage 9 hrs

Oxidation pond – cesspool - septic tank - soak pit. Waste water disposal and reuse. Characteristics and treatment of industrial waste water : breweries and wineries; distilleries; paper and pulp mill; sugar mill; oil refineries. 9 hrs

Petrochemical industries; tanneries; pharmaceutical plants; fertiliser plant; electroplating industries; textile mills. 9 hrs

Treatment and disposal of sludge : thickening and digestion; conditioning and dewatering-incineration - ultimate disposal. 9 hrs

References

1. A Text book of Hydrology and Water Resources. R.K.Sharma. Dhanapath Rai & Sons.
2. Water Supply Engineering - Santosh Kumar, Garg-Khanna Publishers.
3. Environmental Engineering-N.N.Basak, Tata Macgraw Hill publishing company.
4. Pollution control in process industries-S.P.Mahajan.
5. Water Technology. N.F.Gray, Butter worth Heinmann Publications.

SEMESTER - V Paper –I Practicals

1. Determination of chlorine demand a sample of water.
2. Determination of residual chlorine in a municipal water sample.
3. Determination of moisture percentage of soil.
4. Determination of PH of soil.

SEMESTER - V Paper –II Practicals

1. Gravimetric estimation of-
 - a) Sulphate, oxalate
 - b) Barium, Calcium, Iron, Nickel
2. Colorimetry & turbidimetry
 - a) Sulphide, fluoride, silicate, ammonia & sulphate

SEMESTER -VI Paper -I WATER ANALYSIS**54 hrs**

Various methods of analysis; Monitoring techniques and methodology ; Determination of pH - Specific conductance - Dissolved Oxygen, NH_3 , NO_3^- & NO_2^- , Cl^- , F^- , CN^- , S^{2-} , SO_4^{2-} , PO_4^{3-} . 6 hrs

Total hardness (Ca & Mg), B, silica, metals and metalloids As, Se, Be, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ag, Zn. 6hrs

Chemical Oxygen Demand, Biological Oxygen Demand, Total Organic carbon, phenols, pesticides, surfactants, tannin and lignin. Microbial examination : Coliforms (*Escherichia coli*) and total bacteria. 6 hrs

Laboratory analysis of water sample; Determination of Turbidity of water sample - By Jacksons Turbidimeter, Baylis Turbidimeter and Nephelometers. Method to find the odour of a given water sample. 6 hrs

Method to find the colour of a given water sample. Method to determine the pH of given sample of water by colorimetric and electrometric method. 6 hrs

Method to find the carbonate, bicarbonate and hydroxide alkalinity of a water sample. Method to determine the concentration of chlorides of a given water sample. 6 hrs

Method to determine the total hardness of a water sample by standard EDTA method. Determination of residual chlorine in a given sample of water by (a) Orthotoludine Test; (b) Starch Iodide Test; (c) DPD Test 6 hrs

Method to determine the chlorine demand of a water sample; Method to determine the available chlorine percentage in a given sample of bleaching powder. 6 hrs

Method to determine the amount of dissolved oxygen (DO) of a water sample by Winkler Method; Method to find out the Suspended solids (SS), Dissolved solids (DS) and Total Solids (TS) of a water sample. 6 hrs

SEMESTER -VI Paper -(2) Watershed Management**54 hrs**

Watershed – definition - classification of watershed - sub, milli, micro and mini watershed. Hydrology of watershed. 6 Hrs

Eco system in a watershed - Land use changes and resource degradation in watersheds-Agronomic measures for resource management in a watershed - choice of vegetation. 6 hrs

Land preparation - timely planting. Contour farming - multistoried cropping-mixed cropping-Inter cropping - strip cropping; mulching-cover cropping- crop rotation. 6 hrs

Vegetative hedges - barrier grass land management - agroforestry. Engineering measures - tank - vented cross bars and diversion weirs; stone pitched 6 hrs

Contour bunds, contour trenches and embankments of drains. 6 hrs

Water harvesting cum sediment detention tanks, earthen bunds, subsurface dams. 6 hrs

Watershed management for flood control. Geo textiles in watershed management. 6 hrs

Soil conservation; national water grid and river networking; initial attempts for watershed management in India. 6 hrs

An outline study of watershed management in Western Ghats Development Programme. 6hrs

SEMESTER VI Paper I Practicals

1. Volumetric Estimations
 - a) Carbonate hardness-Hehner's method
 - b) Non- Carbonate hardness- Hehner's method
 - c) Mixture of Carbonate-Bi carbonate-warders method (N/20 HCL & std. sodium carbonate (2600 ppm)
 - d) Sulphate ion in H_2SO_4 (N/20 NaOH & std sodium carbonate(2600 ppm)
 - e) Iodine in the solution (N/50 thiosulphate & std pot. dichromate (1000 ppm))

SEM -VI Paper II Practicals

- f) Colorimetric estimations of

i. nitrite	ii. nitrate	iii. phosphate	iv. total nitrogen
v. total phosphorous	vi. sulphide	vii. ammonia	viii. silicate
ix. fluoride	x. ferrous iron and total iron.		

Project :-An investigatory Project report. This work may be based on Environmental Science (significance for Environment) or, project based on Water quality parameters (Local, Regional, state level, or National level important issues can be the topic of interest)

COMPLEMENTARY COURSES

I	Theoretical Inorganic chemistry	3x18=54 hrs
II	Organic and Environmental chemistry	3x18=54hrs
III	Biomolecules and Analytical chemistry	3x18=54 hrs
IV	Physical chemistry	3x18=54 hours

COMPLEMENTARY COURSES (Auxiliary Chemistry)

Semester-I Theoretical and Inorganic Chemistry **54 hours**

Module-1: Atomic Structure **9 Hrs**

Atomic spectrum of Hydrogen - different series, , Bohr theory - postulates - statement of Bohr energy equation - derivation of spectral frequency from Bohr equation. Schrodinger wave equation (no derivation mention only) concept of orbitals, the four quantum numbers and their significances. Orbital wise electron configuration, energy sequence rule - Pauli's principle, Hund's rule, stability of filled and half filled orbitals

Module - II Radio Activity and Nuclear Chemistry **9 Hrs**

Radio active equilibrium (qualitative only). Detection of radio activity by Wilson's cloud chamber and Geiger Muller Scintillation counter - units of radio activity - Curie and Rutherford - Radio Carbon dating , Rock dating, Neutron activation analysis Applications in agriculture and medicine. A brief study of the biological effects of radiation such as pathological and genetic damage, Dosimetry - Units - rad, gray and roentgen. Nuclear Chemistry - stability of Nucleus - n/p ratio, artificial transmutation and radio activity, mass defect, binding energy, atomic fission and fusion.

Module III - Chemical bonding **9 Hrs**

Energetics of bond formation - Types of Chemical bonds - Energetics of ionic bond formation - Lattice energy - Born Haber Cycle - partial covalent nature of ionic bond - Fajan's rules , polarity of covalent bond

its relation with electronegativity - electro negativity scales - PaulingsScalefactors influencing polarity, dipolemoment-its relation to geometry.

Module IV - Chemical bonding II

9 hrs

Hydrogen bond - inter and intra molecular - its consequences on boiling point -volatility and solubility. Hybridisation and structure of molecules - SP, SP², SP³, dSP², dSP³, SP³d², and SP³d³ hybridisation with examples. Explanation of bond angle in water and ammonia VSEPR theory, geometry of molecules with bond pairs of electrons only, geometry of molecules containing bond pairs and lone pairs of electrons, limitations. A brief review of molecular orbital approach, LCAO method -bond order, bond distance and stability of O₂, O₂²⁺, O₂²⁻, NO, NO⁺, CO and HF.

Module V- Metallurgy

9 hrs

General principles of occurrence and extraction of metals - purification, roasting, calcination and smelting, reduction to metal, different method with examples, refining of metals- electrolytic and zone refining. Van - Arkel method. Metallurgy of titanium, thorium and uranium.

Module VI- Coordination Chemistry

9 hrs

Types of ligands, Werner's coordination theory, Valence bond theory of bonding in octahedral and tetrahedral complexes, Drawbacks of valence bond theory crystal field theory of octahedral and tetrahedral complexes, examples - high and low spin complexes, magnetic properties, application in qualitative and quantitative analysis.

Semester II Organic and Environmental Chemistry

(54 hours)

Module I - Introduction to organic reaction mechanisms

9hrs

Types of reactions - substitution, addition, elimination and rearrangement reactions. Electrophilic and nucleophilic reagents - concept of inductive effect, hyper conjugative effect and resonance effect - reaction intermediates - carbocations, carbanions, carbenes, and free radicals - their formation, stability and configuration.

Module II - Stereochemistry

9hrs

Optical isomerism- chirality, racemisation and resolution- relative and absolute configuration- DL and RS notations- asymmetric synthesis- optical isomerism due to restricted rotation- geometrical isomerism- EZ- nomenclature- conformation of ethane, propane, butane and cyclo hexane - Axial and equatorial bonds in cyclo hexane.

Module III- Polymer Chemistry

9 hrs

Classification of polymers based on origin, structure, synthesis, and molecular forces. Commercially important polymers: structure and application of polyethylene, polystyrene, polyhaloolefines, Nylon-6, Nylon-66, Melamine, Terylene, Bakelite, Natural and synthetic rubber, vulcanization, inorganic polymer-silicones.

Module IV - Carbohydrates

9 hrs

Classification- Configuration of glyceraldehydes, erythrose, threose, ribose, arabinose, glucose, fructose and mannose- properties of glucose and fructose-inter conversion of glucose and fructose- Industrial uses of cellulose- of macromolecules.

Module V - Environmental Chemistry

9 hrs

Air Pollution: Types of pollutants in air- carbon monoxide, carbon dioxide, Nitrogen oxides, Sulphur dioxides, hydrogen sulphide, Cl₂, CFC, particulate matter, metals, fly ash, asbestos, hydrocarbons- source

and influence. Acid rain, Green house Gases, Green house effect, ozone layer and its depletion- Sulphatic, phosphatic, nitrogenous, chloride fertilizers-pollution due to long term use of fertilizers. Pesticides like chlorinated hydrocarbons, carbamates, organophosphorous compounds, organometallics, inorganic compounds- Non biodegradable pesticides - Environmental impact of pesticides. Detergents - cationic, anionic and non ionic-water pollution by detergents.

Module VI - Organometallic compounds **9 hrs**

Definition and classification - preparation, properties and applications of Grignard reagents, Ferrocene. Biological and environmental aspects. Applications in medicine, agriculture and horticulture - antitumour drugs.

Semester III Analytical Chemistry and Biomolecules **(54 hours)**

Module I - Spectroscopy I **9 hrs**

Regions of electromagnetic spectrum- interaction of radiation with matter-Variety of molecular spectra- Microwave spectroscopy- spectra of diatomic molecules-selection rule-frequency of separation of spectral line- determination of bond length- Infra red spectra-selection rule-frequency of separation- calculation of bond length.

Module II - Spectroscopy II **9 hrs**

Raman spectroscopy: Stoke's and antistoke's lines - Quantum theory of Raman spectra-advantage and disadvantage -complementary nature of Raman and IR spectra- Mutual exclusion principle.

Module III - Instrumental methods of analysis **9hrs**

Principle, Instrumentation and applications of : Atomic Absorption Spectroscopy- Flame photometry- Nephelometry and turbidimetry- colorimetry- spectrophotometry.

Module IV - Analytical Chemistry **9 hrs**

Solubility product- common ion effect- their applications in qualitative analysis- principles of volumetric analysis- primary standard-standard solution-normality and molarity -theory of acid base indicators-redox indicators-theory of complexometric titration. Accuracy and precision-classification of errors-detection and correction of determinate errors.

Module V - Chromatography **9 hrs**

Outline study of adsorption and partition chromatography-column, paper, thin layer, ion exchange , and gas chromatography- Rf value - relative merits of different techniques- separation of amino acids from mixtures.

Module VI- Bioinorganic compounds **9 hrs**

Metalloporphyrins - photosynthesis and respiration- haemoglobin – myoglobin - mechanism of O₂- CO₂ transportation - nitrogen fixation-carbon fixation - carbon cycle - biochemistry of iron toxicity and nutrition-essential and trace elements of biological systems

Semester IV Physical Chemistry **54 hrs**

Module I- Colloids **9hrs**

Properties of colloids-Tyndall effect-Ultra microscope-Brownian movement-electrophoresis-electroosmosis-sedimentation and streaming potentials- origin of charge and stability of colloids-zeta potential-Hardy Schulz rule- protective colloids-gold number- emulsions-gels-application of colloids-clarification of water-Cottrell precipitator-delta formation-medicines-sewage disposal-emulsification and cleansing action of soaps and detergents.

Module II- Electrochemistry**9 hrs**

Conductance- specific, equivalent and molar conductance-measurement using conductivity meter-variation with dilution - conductometric titration- principle-merits- strong acid-strong base titration & weak acid - strong base titration.

Electrochemical cell- cell potential and electrode potential- standard electrode potential -electro chemical series-SHE -measurement of electrode potential- Nernst equation for electrode potential(No derivation)- Calomel electrode, pH electrodes-Glass electrode, Quinhydrone electrode- fuel cell.

Module III- Binary liquid systems**9 hrs**

Completely miscible liquid pairs, vapour pressure - composition curves, boiling point- composition curves, fractional distillation, Azeotropic mixtures, critical solution temperature, Conjugate layers, phenol-water system. Theory of steam distillation, distribution law, limitations of distribution law, application of distribution law solvent extraction.

Module IV- Thermodynamics**9 hrs**

First law - intrinsic energy and enthalpy - work done during reversible isothermal expansion-second law of thermodynamics-entropy and free energy - concept of spontaneity and reversibility, Gibb's Helmholtz equation - derivation of relation between heat of reaction at constant pressure and constant volume - Hess's law - bond energy and bond dissociation energy -measurement based on Hess's law - Third law of thermodynamics.

Module V- Equilibrium**9 hrs**

Chemical equilibrium - relation between K_p and K_c -Vant Hoff's isotherm equation and isochoric equation- relation connecting equilibrium constant and degree of dissociation for the following systems: 2NH_3 , $\text{N}_2 + 3\text{H}_2$, PCl_5 , $\text{PCl}_3 + \text{Cl}_2$ - degree of dissociation- determination from density measurement- Le Chatelier principle and its applications. Concept of acid and bases-ionic product of water- pH, pOH, pK_w - ionization constants of weak acids and bases- Buffer solution- Henderson equation-calculation of pH of solutions.

Module VI- Chemical Kinetics, Catalysis and Photochemistry**9hrs**

Order and molecularity, derivation of rate equation for zero, first and second order reactions (same initial concentrations) - determination of order of reactions—effect of temperature on rate of reactions-concept of activation energy-illustration of exothermic and endothermic reactions based on it- Arrhenius equation-determination of Arrhenius parameters -intermediate compound formation theory and adsorption theory of catalytic reactions.

Practicals**Semester I & II- Qualitative Analysis****72 hrs**

- 1) Reactions of anions - carbonate, sulphide, sulphate, thiosulphate, oxalate, nitrite, nitrate, chloride, phosphate, fluoride (No exam)
- 2) Identification by flame colouration : Lithium, sodium, potassium, barium, calcium, strontium(No exam)
- 3) Reactions of cations: Ag^+ , Pb^{2+} , Bi^{3+} , Cu^{2+} , Al^{3+} , Fe^{2+} , Fe^{3+} , Zn^{2+} , Mn^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Mg^{2+} , NH_4^+
- 4) Analysis of solution containing mixture of two cations- at least 10 mixtures (Avoid same group)

Semester III & IV- Quantitative Analysis**72 hrs****I. Volumetric Analysis**

- a) Acidimetry and alkalimetry

- 1) Estimation of NaOH using Na_2CO_3
 - 2) Estimation of KOH using Na_2CO_3
 - 3) Estimation of K_2CO_3 using Na_2CO_3
 - 4) Estimation of H_2SO_4 using oxalic acid
 - 5) Estimation of HNO_3 using oxalic acid
- b) Permanganometry
- 1) Estimation of Fe^{2+} using oxalic acid
 - 2) Estimation of sod.oxalate using Mohr's salt
 - 3) Estimation of Fe^{2+} using oxalic acid
 - 4) Estimation of Mohr's salt using oxalic acid
- c) Dichrometry
- 1) Estimation of Fe^{2+} using internal indicator
 - 2) Estimation of Fe^{2+} using external indicator
- d) Iodometry and Iodimetry
- 1) Estimation of iodine
 - 2) Estimation of copper
- e) Complexometry
- 1) Estimation of Zinc
 - 2) Estimation of Mg

II Gravimetric Analysis (No Exam)

- 1) Estimation of water of hydration in barium chloride crystals
- 2) Estimation of barium in barium chloride solution

References

- 1) Atomic structure and chemical bonding with introduction to molecular spectroscopy, Manas Chanda.
- 2) Concise Inorganic Chemistry, J.D. Lee
- 3) Elements of Nuclear Chemistry, Arnikaar
- 4) Environmental Chemistry, A.K De.
- 5) Essentials of Physical Chemistry, Bahl, Tuli and Arun Bahl.
- 6) A. I. Vogel, "Text book of Qualitative Analysis"
- 7) A. I. Vogel, "Text book of Quantitative Inorganic Analysis".
- 8) A. K. Srivasthava and P. C. Jain, "Chemical Analysis".
- 9) Coordination Chemistry : Bosolo and Johnson.
- 10) Coordination Chemistry : S. F. A. Kettle.
- 11) Instrumental Methods of Analysis, B.K Sharma.

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