MASTER OF SCIENCE

(M.Sc.)

WATER RESOURCES AND ENVIRONMENTAL MANAGEMENT

COURSE STRUCTURE AND SYLLABI

(As per Guidelines of CBCS of UGC)

(W.E.F. 2019-21)

(Revised in June 2019)

DEPARTMENT OF ENVIRONMENTAL SCIENCES

SCHOOL OF BASIC SCIENCES AND RESEARCH

SHARDA UNIVERSITY

1. TITLE: Master of Science in Environmental Sciences (Water Resources and Environmental Sciences)

2. DURATION OF THE COURSE: 2 YEARS

3. YEAR OF IMPLIMENTATION

This syllabus will be implemented from August 2019 onwards.

4. PREAMBLE

Total Credits- 93 (25+28+22+18)

Total Number of Semesters – 4 (Two semesters per year)

Total Number of Theory Papers – 18

Total Number of Practical courses – 06

Dissertation-01(Part-A: Draft + Part-B: Final Report Submission)

Number of papers (theory) per semester – 06/06/04/02

Number of Laboratory courses per semester (except IV) – 01/02/02

5. COURSE STRUCTURE

Semester	CORE COURSE (13)	Elective: Discipline Specific DSE (2)	Elective: Generic (GE) (2)	SEEC
I	Water Resources & Management		GE-1	
	Environmental Chemistry			
	Environmental Pollution			
	Hydrology			
	Solid Waste Management and Treatment			
II	Environmental Law, Policy & Audit		GE-2	Community Connect
	Climate Change & Sustainable Development			
	Environmental Toxicology			
	Glaciology & Climate Change			
	Remote Sensing & GIS			
III	Environmental Impact & Risk Assessment	DSE-1		
	Water Purification & Treatment Processes			
	Research Methodology			
	Water Sanitation and Health			
IV	Ground Water Quality and Management	DSE-2 DSE-3		
Credits	**66**	**18**	**7**	**2**

Core Papers (C):

1. Water Resources & Management
2. Environmental Chemistry
3. Environmental Pollution
4. Hydrology
5. Solid Waste Management and Treatment
6. Environmental Legislation & Audit
7. Climate Change & Sustainable Development
8. Environmental Toxicology
9. Glaciology & Climate Change
10. Remote Sensing Techniques & GIS
11. Environmental Impact & Risk Assessment
12. Water Purification & Treatment Processes
13. Research Methodology
14. Water Sanitation and Health
15. Ground Water Quality and Management
16. Industrial Waste Water Treatment

Discipline Specific Elective Papers (DSE):

TERM-III

1. Dissertation Part-A

TERM-IV

2. Industrial Waste Water Treatment
1. Dissertation Part-B

Other Discipline – GE-I to GE-II

1. Earth, Ecology and Environment
2. Energy sources and Global Scenario

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Core course-I	Water Resources & Management	4
	Core course-II	Environmental Chemistry	4
	Core course-III	Environmental Pollution	4
	Core course-IV	Hydrology	4
	Core course-V	Solid and Hazardous Management	4
	Core course-VII Practical	Water Pollution & Monitoring Lab	2
	Generic Elective-I	Earth, Ecology and Environment	3
II	Core course-VIII	Environmental Legislation & Audit	4
	Core course-IX	Climate Change & Sustainable Development	4
	Core course-X	Environmental Toxicology	4
	Core course-XI	Glaciology & Climate Change	4
	Core course-XII	Remote Sensing Techniques & GIS	4
	Core course-XII Practical	Remote Sensing & GIS Lab	2
	Generic Elective-II	Energy Sources and Global Scenario	4
	SEEC	Community Connect	2
III	Core course-XIII	Environmental Impact & Risk Assessment	4
	Core course-XIIV	Water Purification & Treatment Processes	4
	Core course-XV	Research Methodology	4
	Core course-XVI	Water Sanitation and Health	4
	Discipline Specific Elective-I	Dissertation-1	4
	Core course-XVII Practical	Environmental Data Analysis	2
IV	Core course-XVII	Ground Water Quality and Management	4
	Discipline Specific Elective-II	Industrial Waste Water Treatment	4
	Discipline Specific Elective-IV	Dissertation-2	10

Program Structure
School of Basic Sciences & Research
M. Sc. Water Resource and Environmental Management
Batch: 2019-2021
TERM: I

S. No.	Subject Code	Subjects	Teaching Load			Credits	Pre-Requisite/Co Requisite
			L	T	P		
THEORY SUBJECTS							
1.	MWE-101	Water Resources & Management	4	-	-	4	Core
2.	MWE-102	Environmental Chemistry	4	-	-	4	Core
3.	MWE-103	Environmental Pollution	4	-	-	4	Core
4.	MWE-104	Hydrology	4	-	-	4	Core
5.	MWE-110	Solid Waste Management and Treatment	4	-	-	4	Core
6.	MEE114	Earth Ecology and Environment	3	-	-	3	GE-1
Practical							
7.	MWE-151	Water Pollution & Monitoring Lab	0	0	4	2	Core
TOTAL CREDITS						**25**	

Program Structure
School of Basic Sciences & Research
M. Sc. Water Resource and Environmental Management
Batch: 2019-2021
TERM: II

S. No.	Paper ID Subject Code	Subjects	Teaching Load			Credits	Pre-Requisite/Co Requisite
			L	T	P		
THEORY SUBJECTS							
1.	MWE-111	Environmental Legislation and Audit	4	-	-	4	Core
2.	MWE-106	Climate Change & Sustainable Development	4	-	-	4	Core
3.	MWE-107	Environmental Toxicology	4	-	-	4	Core
4.	MWE-108	Glaciology & Climate Change	4	-	-	4	Core
5.	MWE-112	Remote Sensing Techniques & GIS	4	-	-	4	Core
6.	MEE112	Energy Sources and Global Scenario	4	-	-	4	GE-2
Practical							
7.	MWE-152	Remote Sensing & GIS	0	0	4	2	Core
8.	CCU-401	Community Connect Course	0	0	4	2	SEEC
TOTAL CREDITS						**28**	

Program Structure
School of Basic Sciences & Research
M. Sc. Water Resource and Environmental Management
Batch: 2019-2021
TERM: III

S. No.	Subject Code	Subjects	Teaching Load			Credits	Pre-Requisite/Co Requisite
			L	T	P		
THEORY SUBJECTS							
1.	MWE-201	Environmental Impact & Risk Assessment	4	-	-	4	Core
2.	MWE-202	Water Purification & Treatment Processes	4	-	-	4	Core
3.	MWE-203	Research Methodology	4	-	-	4	Core
4.	MWE-205	Water Sanitation and Health	4	-	-	4	Core
Practical							
5.	MWE-261	Dissertation -1	0	0	8	4	Core
6.	MWE-252	Environmental Data Analysis	0	0	4	2	Core
TOTAL CREDITS						**22**	

Program Structure
School of Basic Sciences & Research
M. Sc. Water Resource and Environmental Management
Batch: 2019-2021
TERM: IV

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
Practical							
1.	MWE-263	Dissertation-2	-	-	20	10	Core
2.	MWE-206	Ground Water Quality and Management	4	-	-	4	Core
3.	MWE-207	Industrial waste water treatment	4	-	-	4	Core
TOTAL CREDITS						**18**	

1.1 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: I**
1	Course Code	MWE101
2	Course Title	**Water Resource and Management**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Provide an insight into global water problems and various related laws 2 . Enable understanding of management and planning of water resources 3: Provide a thorough concept on watersheds and various projects related to watershed 4: Enable students to understand the appropriate measures to overcome flood and drought situations by adopting proper management plans 5: To impart comprehensive knowledge related to economic planning and techniques deals with water related conflict 6: Overall in-depth understanding of various available water resources, its planning and management and various associated socioeconomic components
6	Course Outcomes	CO1: Includes introduction to water problems and various constitutional provision related to deal with water related issues. CO2: Knowledge on water resources planning and development and addresses social goals CO3: The concepts on watershed, its objectives, and conservation strategies and describe role of people's participation CO4: Demonstrate causes and various issues related with flood and

		drought and various mitigation plans CO5: Detailed overview on understanding the advantage of economic planning in addressing water related issues CO6: Thorough understanding of available water resources, various water related issues and management plans to conserve the resources.	
7	Course Description	To develop thorough understanding of various water related problems and laws related to its use and distribution. Moreover it also cover various management practices that are adopted to ensure proper utilization of the resources. Further this course also focus on various water related problems like flood and drought and various management plans to be implemented during such situations.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Global and national water problems, Quantity estimation of water –urban and rural sectors' requirement	CO1/CO6
	B	Water Laws: Constitutional provisions, National Water Policy	CO1/CO6
	C	Riparian rights / ground water owner ship, prior appropriation, permit systems, acquisition and use of rights, scope for privatization.	CO1/CO6
	Unit 2	**Water Resource Management**	
	A	Objectives: of water resource planning and management, its necessity	CO2/CO6
	B	Aspects of water resources planning, water resource development	CO2/CO6
	C	Needs and opportunities, social goals	CO2/CO6
	Unit 3	**Watershed management**	
	A	Objectives of Planning Watershed Projects, Guidelines for Project Preparation	CO3/CO6
	B	Approach in Govt. programmes, people's participation, conservation farming	CO3/CO6
	C	Watershed management planning, identification of problems, objectives and priorities, socioeconomic survey	CO3/CO6

	Unit 4	**Flood management**			
	A	causes of floods, structural and non-structural measures, mitigation plan, flood damage assessment,			CO4/CO6
	B	Drought management: types of droughts, severity index			CO4/CO6
	C	Drought forecasting, damage assessment, mitigation plan			CO4/CO6
	Unit 5	**Economic planning**			
	A	Discounting techniques, benefit cost parameters, estimation of benefits and costs			CO5/CO6
	B	Appraisal criteria, social benefit cost analysis			CO5/CO6
	C	Basin planning; inter-basin transfer of water			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Water Resources Systems Engg, D. P. Loucks, Prentice Hall 2. Chaturvedi, M.C. "Water Resources Systems Planning and Management" Tata McGraw Hill 3. James L.D and Lee R.R "Economics of Water Resources Planning", McGraw Hill 4. Water resources hand book; Larry W. Mays, McGraw International Edition			
	Other References				

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	3	3	2	2	2
CO2	3	1	2	1	1	3	2	3
CO3	1	1	2	2	2	1	1	3
CO4	1	1	2	3	2	1	3	2
CO5	2	1	2	2	2	1	2	2
CO6	2	2	3	2	2	2	2	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

1.2 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: I**
1	Course Code	MWE102
2	Course Title	**Environmental Chemistry**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Provide an insight into basic concept of chemistry 2 Enable to determine and investigate various water quality parameters 3: Provide a thorough concept on various chemical reactions takes place in the atmosphere 4: Enable to gain thorough knowledge on water chemistry and various related chemical reactions. 5: Detail understanding of the soil structure and various physicochemical factors influences soil formation 6: Overall in-depth understanding of various chemical reactions occurs in different segments of environments and factors affecting these reactions.
6	Course Outcomes	CO1: Basic concept of chemistry and principles governing environmental reactions CO2: Knowledge of chemical water quality parameters CO3: The concepts of various chemical reactions takes place in the atmosphere CO4: Basic water chemistry and reactions CO5: Basic chemical and biological reactions occur in soil and affecting soil formation process. CO6: Overall understanding and knowledge of basic principles of

		environmental chemistry	
7	Course Description	To develop an understanding of basic principles that regulate and influence water, atmosphere and soil chemistry.	
8	Outline syllabus		CO Mapping
	Unit 1	**Basic Concept of Chemistry**	
	A	Stoichiometry, Gibb's energy	CO1/CO6
	B	Chemical potential, chemical equilibria, acid base reactions	CO1/CO6
	C	Solubility product, solubility of gases in water	CO1/CO6
	Unit 2	**Concept and Scope of Environmental Chemistry**	
	A	Definition, Scope & Importance of Environmental Chemistry	CO2/CO6
	B	Definition and explanation for various terms: Acid, Base, pH	CO2/CO6
	C	Dissolved Oxygen, Biochemical oxygen demand, Chemical Oxygen Demand	CO2/CO6
	Unit 3	**Atmospheric Chemistry**	
	A	Atmospheric structure, Atmospheric composition	CO3/CO6
	B	Air pollution, Chemistry of Greenhouse gases, Acid rain	CO3/CO6
	C	Reactions, Primary and Secondary Pollutants, Photochemical Smog	CO3/CO6
	Unit 4	**Hydrospheric**	
	A	Water chemistry basics, Water Structure and Anomalous Behaviour of Water	CO4/CO6
	B	Oxidation and reduction, Dispersions, Dissolution and precipitation	CO4/CO6

	C	Chemical characteristics of water, Self-cleaning capacity			CO4/CO6
	Unit 5	**Pedospheric Chemistry**			
	A	Introduction to Soil Chemistry, Composition, Soil Profile, Formation of Soil			CO5/CO6
	B	Physico-Chemical Properties of Soil, Soil Reactions (Cation & Anion Exchange Phenomenon)			CO5/CO6
	C	Major Nutrients of Soil, Biogeochemical pathways			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Environmental Chemistry: A.K. Dey, (Wiley Eastern Ltd), 1987. 2. A Text book of Environmental Chemistry: O.D. Tyagi, M. Mehra (Anand Publications Pvt, Ltd) 1994.			
	Other References				

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	3	2	3	1
CO2	2	2	1	3	2	3	3	2
CO3	2	2	2	1	2	1	1	3
CO4	2	1	1	2	2	2	2	3
CO5	2	1	2	2	2	1	2	2
CO6	2	2	2	2	2	2	2	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

1.3 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: I**
1	Course Code	MWE103
2	Course Title	**Environmental Pollution**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Understanding of basics of pollution, types of air pollutants its sources and various impacts on human health and environment 2. Enable understanding of various physical factors influencing dispersion of air pollutants 3: Provide a thorough concept on factors affecting water quality, major water pollutants, global water crisis, and treatment of wastewater 4: Enable students to understand types of soil, impact of industrialization and urbanization on soil quality and control measures 5: To impart knowledge on solid wastes, its types, and various disposal strategies 6: Overall this course helps in-depth understanding of basics of air, water and soil pollution, and various control measures adopted for the abatement of pollution
6	Course Outcomes	CO1: Includes introduction and classification of air pollutants, its sources and its effects on local, regional and global scale. CO2: Knowledge on types on air pollutants, and analysis of various meteorological parameters responsible for dispersion of air pollutants in the atmosphere CO3: The concept of water quality and standards, various water pollution sources, effects and techniques employed for wastewater treatment CO4: Identification of soil types, and factors deteriorating the soil quality and various control measures to protect the critically degraded soil CO5: An overview on solid wastes its types, sources and various disposal strategies CO6: Thorough understanding of sources and factors responsible for

		air, water and soil pollution and various remedial measures employed in order to reduce the effect of pollution and abatement of pollutants.	
7	Course Description	To develop in-depth understanding of various aspects of air, water, and soil pollution. The course extensively covers various strategies that are being used for the control and abatement of the pollution.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Definition, Classification of Pollution and Pollutants, Causes, Effects and Sources of Pollution	CO1/CO6
	B	Impacts of pollution on human health and biodiversity	CO1/CO6
	C	Effect of pollution in global, regional and local scale	CO1/CO6
	Unit 2	**Air Pollution**	
	A	Primary and Secondary Pollutants, Automobile Pollution, Industrial Pollution, Ambient Air Quality Standards and indices	CO2/CO6
	B	Meteorological aspects of air pollution- Wind profiles, Turbulent diffusion, Topographic effects, Temperature profiles in atmosphere, lapse Rates and Stability, Inversion, Plume behaviour	CO2/CO6
	C	Dispersion of air pollutants- solutions to the atmospheric dispersion equation - the Gaussian Dispersion Model, Instrumentation technique to control air pollution.	CO2/CO6
	Unit 3	**Water Pollution**	
	A	Point and Non-point Source of Pollution, major Pollutants of Water, Water Quality Requirement for different Uses	CO3/CO6
	B	Global water crisis Issues, Water quality standards, Coastal Pollution Due to Industrial Effluents, Effects of water pollution and its control	CO3/CO6
	C	Water and waste water treatment- primary and secondary treatment methods	CO3/CO6
	Unit 4	**Soil Pollution**	
	A	Classification of soil types, Effects of urbanization on land degradation	CO4/CO6
	B	Impact of Modern Agriculture on Soil, Effect on Environment and Life sustenance	CO4/CO6
	C	Abatement measures, Effects and Control measures.	CO4/CO6
	Unit 5	**Solid Waste Pollution**	
	A	Solid waste Classification, Different sources of Solid	CO5/CO6

		waste			
	B	Different methods of Disposal, Effect of urban and industrial solid waste on environment			CO5/CO6
	C	Control methods, incineration, landfill			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Text book of Environmental Science and Technology by Dr. M. Anji Reddy, BS Publications, 2010. 2. Environmental Science- Towards a sustainable future by Richard T. Wright, PHI Learning, New Delhi 2008.			
	Other References				

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1	2	1	1	1
CO2	2	2	1	2	2	2	3	2
CO3	3	2	2	3	3	2	2	2
CO4	2	1	1	2	2	2	2	3
CO5	2	1	3	2	2	1	1	2
CO6	2	1	2	2	2	2	1	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

1.4 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: I**
1	Course Code	MWE104
2	Course Title	**Hydrology**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Understanding of basics of concept of hydrological cycle, monsoon system 2. Enable understanding of various physical factors influencing precipitation, types of precipitation, technical analysis of precipitation data 3: Provide a thorough concept on discharge and runoff 4: Enable students to understand about flood, its frequency and techniques of estimation. 5: To impart knowledge on ground water hydrology including concept of aquifer, groundwater flow and related phenomena 6: Overall this course helps in-depth understanding of various process and phenomenon related with hydrology.
6	Course Outcomes	CO1: Understanding of role of hydrological cycle, knowledge of hydrologic budget. CO2: Knowledge on types on precipitation, its process, various technical aspects related with precipitation CO3: It deals with the discharge process runoff, and its quantitative estimation CO4: It gives understanding of flood, various technical aspects related with flood including flood frequency studies, flood routing

		concept etc. CO5: To understand the concept of aquifers, its types and various hydraulic phenomenon associated with aquifers CO6: Thorough understanding of various hydrological process and related hydrological events and related technical aspects.	
7	Course Description	To develop in-depth understanding on monsoon system, factors regulating hydrological cycle and water budget. Also provide focus on precipitation process and ways of analysis of precipitation data. Further this course also throws light on various analytical and technical component related with flood, in depth overview on ground water hydrology that includes concept of aquifers, Darcy's law and hydraulic potential.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Definition, need, history of hydrology	CO1/CO6
	B	world water inventory, the Indian scenario	CO1/CO6
	C	The hydrologic cycle, hydrologic budget, the monsoon system.	CO1/CO6
	Unit 2	**Precipitation**	
	A	Precipitation: process, forms, assessment of precipitation in ungauged basins, Analysis of Precipitation data: required number of rain gauges, data consistency check and data gap fill up	CO2/CO6
	B	Presentation of rainfall data–mass curve and hyetograph, precipitation variability, , estimation of mean precipitation over an area, depth area relationship	CO2/CO6
	C	Intensity duration-frequency relationship, probable maximum precipitation, Horton's equation and phi index method	CO2/CO6
	Unit 3	**Discharge and Runoff**	

	A	Measurement of Discharge, direct and indirect estimation methods, measurement of stage Runoff: components, water yield, flow duration curve, flow mass curve			CO3/CO6
	B	Hydrograph, factors affecting flood hydrograph, Unit Hydrograph-definition, assumptions, limitation, derivation of UH from storm hydrograph, derivation of UH of longer duration from UH of shorter duration			CO3/CO6
	C	Derivation of UH of shorter duration from UH of longer duration, derivation of storm hydrograph from UH			CO3/CO6
	Unit 4	**Flood**			
	A	Estimation of flood peak-Rational method, empirical formulae, Unit Hydrograph techniques			CO4/CO6
	B	Flood frequency studies; Flood Routing concept and techniques; hydrologic reservoir routing using Modified Pulse method			CO4/CO6
	C	Hydrologic channel routing using Muskingum method			CO4/CO6
	Unit 5	**Ground water hydrology**			
	A	Concept of aquifers, flow of water to a well in confined and unconfined aquifers, infiltration			CO5/CO6
	B	Soil properties, Darcy's Law and Hydraulic Potential, The Steady-state			CO5/CO6
	C	Groundwater Flow Equation Streamlines and Flow Nets, Regional Flow and Geologic Controls on Flow			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Subramanya K. (2004) Engineering Hydrology, Tata McGraw-Hill, New Delhi. 2. Chow V.T. (1988) Applied Hydrology, Tata McGraw Hill Publishing Co.			

		3. Patra K.C. (2011) Hydrology and Water Resources Engineering, Narosa Publishing House	
	Other References		

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1	1	1	1
CO2	2	2	2	2	1	1	1	1
CO3	2	2	2	2	1	1	2	1
CO4	2	1	3	2	2	2	2	1
CO5	3	1	3	2	2	1	1	2
CO6	3	1	2	2	2	2	1	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

1.5 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-2021**	
Program: M. Sc		**Current Academic Year: 2019-2020**	
Branch: Water Resource and Environmental Management		**Semester: I**	
1	Course Code	MWE-110	
2	Course Title	**Solid Waste Management and Treatment**	
3	Credits	04	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. Definition, Types, Sources of solid waste 2. Understanding about handling of solid waste 3. Understanding about processing techniques of solid waste 4. Understanding about the hazardous waste management 5. Understanding about the hazardous waste treatment.	
6	Course Outcomes	CO1.Understanding about the definition, types, sources of solid waste. CO2. Understanding about solid waste handling CO3. Understanding about solid waste processing techniques CO4.Understanding about the hazardous waste management CO5.Understanding about the hazardous waste treatment. CO6. Overall in-depth understanding of Solid and hazardous waste management.	
7	Course Description	Solid & Hazardous Waste Management emphasises on various factors as 1. Definition, Types, Sources of hazardous waste and its impact on environment 2. Handling and segregation of solid waste 3. Solid waste management and its processing technologies 4. Hazardous waste management processes 5. Hazardous waste treatment	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Definition, Types, Sources	CO1/CO6
	B	Composition of solid waste, Characteristics, and Impact on Environmental Health,	CO1/CO6
	C	Determinants of Solid waste-factors influencing Waste Generation Rates, Concepts of Waste Reduction,	CO1/CO6

		Recycling and Reuse	
	Unit 2	**Handling of Solid Waste**	
	A	Handling and Segregation of Wastes at Source	CO2/CO6
	B	Collection of Solid waste – collection services – collection system, equipments – time and frequency of collection – labour requirement – factors affecting collection – analysis of collection system – collection routes –and Transfer and Transport: Need for transfer operation – transfer stations – types – transport means and methods – location of transport stations , Transfer stations – selection of location,	CO2/CO6
	C	Analysis of Collection Systems	CO2/CO6
	Unit 3	**Solid Waste Processing Techniques**	
	A	Solid Waste Processing Technologies, Mechanical and Thermal Volume Reduction	CO3/CO6
	B	Biological and Chemical Techniques for Energy and Other Resource Recovery	CO3/CO6
	C	Disposal in Landfills – Site Selection, Design, and Operation of Sanitary Landfills, Secure Landfills.	CO3/CO6
	Unit 4	**Hazardous Waste Management**	
	A	Need for Hazardous Waste management, Sources and Characteristics	CO4/CO6
	B	Handling, Collection, Storage and Transport	CO4/CO6
	C	Hazardous Waste Treatment Technologies.	CO4/CO6
	Unit 5	**Hazardous Waste Treatment**	
	A	Solidification, Chemical Fixation and Encapsulation	CO5/CO6
	B	Incineration. Hazardous Waste Landfills -Site Selection Design and Operation	CO5/CO6
	C	.E-Waste - Waste Categorization Generation, Collection, Transport, Treatment and Disposal	CO5/CO6

	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	**Reference Books:** **1**. Handbook of Solid Waste Management, F. Kreith, G. Tchobanoglous, 2009. **2.** CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000. **3.** Pollution Control, Climate Change and Industrial Disasters, Abbasi, T. and Abbasi, S.A. Discovery Publishing House, New Delhi (2010). **4.** Hazardous Waste Management, M. D. LaGrega, P. L Buckingham, J. C. Evans, 2nd edition. McGraw-Hill, 2011.			
	Other References				

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2	2	3
CO2	3	2	3	2	2	2	2	3
CO3	3	2	3	2	2	2	2	3
CO4	3	2	3	2	2	2	2	3
CO5	3	2	3	2	2	2	2	3
CO6	3	2	3	2	3	3	3	3

2.1 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-20**
Program: MSc		**Current Academic Year: 2019-21**
Branch: Water Resources and Environmental Management		**Semester: II**
1	Course Code	MWE-111
2	Course Title	**Environmental Legislation and Audit**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Understanding of various laws enacted at global level for the protection and conservation of environment. 2. Understanding of various law implemented at national level for the abatement of pollution and conservation of environment. 3: Provide a thorough concept on various environmental policies 4: Understanding of various provisions related to environment protection and important judgement and cases 5: Enable to comprehend the concept of environmental auditing 6: Overall this course helps in-depth understanding of various rules, regulation and policies related to the protection of environment
6	Course Outcomes	CO1: Understanding of role of Stockholm conference, Rio declaration and role of United Nation in protection of global environment. CO2: Knowledge various types of laws enacted for the prevention and protection of environment and abatement of pollution. CO3: It deals with various policies, rules and regulations in safeguarding our environment. CO4: It gives understanding of the duties and responsibilities towards environmental protection and important judgement and cases CO5: To understand the concept of environmental auditing and techniques of auditing CO6: Thorough and indepth understanding of various environmental related laws, regulations and policies that helps keeps our environment preserved and protected.
7	Course Description	To develop in-depth understanding on various laws enacted to make use of the natural resources like air, water, and forest in a sustainable manner. The course also covers various duties and responsibilities

		towards environment as a citizen of India. It also introduce a concept of environmental auditing, its types and the techniques to carried out auditing.	
8	Outline syllabus		CO Mapping
	Unit 1	**International Environmental Law**	
	A	Evolution and development of International Environmental laws with reference to Stockholm Conference, Nairobi Declaration	CO1/CO6
	B	Rio+5, Rio+10 (Johannesburg Summit), Rio+20 etc. Agenda-21, Basel Convention on the control of transboundary movement etc.	CO1/CO6
	C	Global environmental issues and laws: to control Global warming, Ozone depletion, CITES. Role of UN in protection of Global Environment	CO1/CO6
	Unit 2	**Environmental law**	
	A	The Water (Prevention and Control of Pollution) Act 1974, Water cess act-1977,Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981	CO2/CO6
	B	Environment (protection) Act 1986, Factories Act, Motor Vehicle Act , Solid waste management and hazardous rules	CO2/CO6
	C	Coastal Regulation Zones (CRZ) Rules 1991. Bio-Medical Waste (Management and Handling) Rules, 1998	CO2/CO6
	Unit 3	**Pollution abatement policies, rules and regulations**	
	A	Environmental Policy and laws. The role of courts	CO3/CO6
	B	Role of central & state Government	CO3/CO6
	C	Central & State pollution control boards for Safeguard for Environmental Protection	CO3/CO6
	Unit 4	**Environmental protection and important judgment and cases**	
	A	Duties and responsibilities of citizens in environmental protection, Public liability Insurance Act. 1991	CO4/CO6
	B	Important legislations related to environment: Provision of constitution of India regarding environment (article 48 A & 58A)	CO4/CO6
	C	Important Judgments and Cases: Discussion on landmark cases: Sriram Chemicals Oleum Leak Case, Bhopal Gas Leak case, Ganga Action Plan case etc. Green Benches.	CO4/CO6

	Unit 5	**Environmental Audit**			
	A	Guidelines for Environmental Audit,Concept of environmental audit, objectives of audit, types of audit, Matrix Method and Baetelle Method of Auditing			CO5/CO6
	B	Organisation of Auditing Programme-pre visit and collection. Audit protocol, onsite audit, data sampling-Inspections-Evaluation and presentation			CO5/CO6
	C	Exit interview, Audit report-Action plan-Management of audits.			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Divan S. and Rosencranz A. (2005) Environmental Law and Policy in India, 2nd ed., Oxford, New Delhi. 2. Leelakrishnan P. (2008) Environmental Law in India, 3rd ed., Lexis Nexis, India			
	Other References				

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	2	1	1	1	2
CO2	3	1	2	2	2	1	1	2
CO3	2	1	2	3	2	1	1	1
CO4	2	1	2	2	2	1	1	2
CO5	3	1	3	2	2	1	1	1
CO6	3	1	2	2	2	2	1	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

2.2 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: II**
1	Course Code	MWE106
2	Course Title	**Climate Change and Sustainable Development**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Understanding of various components of climate and related events 2. Understanding of green house effect concept and factors responsible for and role of IPCC towards climate change 3: Provide a thorough concept on sustainable development and various elements of sustainable development 4: Understanding of sustainable development in terms of business perspective 5: Enable to comprehend the concept of climate change and various policies initiated by government for mitigation. 6: Overall this course helps in-depth understanding of climate change, elements that responsible for climate change and various governmental approach for its mitigation.
6	Course Outcomes	CO1: Understanding of climate and its components, concept of global circulation CO2: Understanding of factors responsible for green house effect and global warming and role of IPCC CO3: It deals with the concept and understanding of sustainable

		development CO4: To understand the concept of sustainable development and its role in various business related activities. CO5: It gives clear understanding of the relation between climate change mitigation and sustainable development. CO6: Thorough and indepth understanding of the causes responsible for climate change and ways of mitigating climate change by adopting governmental policies and promoting sustainable development.	
7	Course Description	To develop in-depth understanding of climate and its related components. Factors that affecting the climate and leads to climate change. Various policies, regulations and efforts taken at global level in tackling the problem of climate change. Further the course also throws light on the interrelationship between sustainable development and climate change mitigation.	
8	Outline syllabus		CO Mapping
	Unit 1	**International Environmental Law**	
	A	Weather and climate, Difference between Weather & Climate, Components of Earth's climate system	CO1/CO6
	B	Pressure, temperature, humidity, clouds, precipitation	CO1/CO6
	C	General circulation, Hadley cells, prevailing winds and weather. Ocean circulation and El Niño events	CO1/CO6
	Unit 2	**Environmental law**	
	A	Factors driving Natural and Anthropogenic sources of GHG emissions to the atmosphere	CO2/CO6
	B	Global warming potential, impact of climate change on ecosystem	CO2/CO6
	C	Kyoto Protocol, Role of IPCC in climate change impact	CO2/CO6
	Unit 3	**Sustainable Development**	

	A	Definition of Sustainable Development, Need of Sustainable Development,			CO3/CO6
	B	Environmental Sustainability, Economic Sustainability, Social Sustainability			CO3/CO6
	C	Sustainable Agriculture. Human Development and Sustainability			CO3/CO6
	Unit 4	**Sustainable Development and Business Perspective**			
	A	Sustainable Development and Business Strategy Prospective			CO4/CO6
	B	Corporate Social Responsibility, Industrial Ecology			CO4/CO6
	C	Enhancing Environment Management Systems			CO4/CO6
	Unit 5	**Environmental Audit**			
	A	Use of alternate energy resources for sustainability			CO5/CO6
	B	Govt. Policies for Mitigation – Current Status & Future Planning			CO5/CO6
	C	National & International Initiative			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Sustainable Development: Economics & Environment in the Third World, David William Pearce, Edward Barbier, Anil Markandya, Earthscan, 1990. 2. Sustainable Development: Critical Issues, Organisation for Economic Co-Operation and Development, OECD Publishing, 28-Jun-2001Environmental Impact Assessment, L. W. Canter, Mc Graw Hill, New York, 2010. 3. Climate Change: Physical Science Basis. IPCC, 2013.			

	Other References							

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	3	1	1	2
CO2	2	1	2	1	2	1	1	2
CO3	2	1	2	2	2	1	1	1
CO4	2	1	2	2	2	1	1	2
CO5	3	1	3	3	2	1	1	1
CO6	3	1	3	3	2	1	1	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

2.3 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: II**
1	Course Code	MEW107
2	Course Title	**Environmental Toxicology**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Understanding of various concepts related with toxicology, types of toxicants and toxicity as a function of dose response relationship. 2. Understanding of various mechanisms related with toxicity and detoxification process. 3: Provide a thorough concept on hepato, renal and immuno toxicology. 4: Impact of nano particles related toxicity in environment and human 5: Enable to comprehend the concept of environmental health 6: Overall this course helps in-depth understanding of various sources, effects and mechanism of toxicity.
6	Course Outcomes	CO1:Concept of toxicology and its sources CO2:Dose response relationship CO3: Mechanism of toxicity CO4:Problems caused due to toxic chemicals CO5: Nano particles and its toxicity and human exposure and diseases CO6: Overall understanding of various sources, effects and mechanisms of toxicity.

7	Course Description	To develop basic understanding of sources and mechanism of toxicity	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Toxicology**	
	A	General concept of toxicology and toxic chemical in environment	CO1/CO6
	B	Sources and mechanism of toxicity	CO1/CO6
	C	Dose-response relationship	CO1/CO6
	Unit 2	**Toxicity Mechanisms**	
	A	Bioaccumulation	CO2/CO6
	B	Bio-magnification	CO2/CO6
	C	Bio-transformation	CO2/CO6
	Unit 3	**Chemical Toxicology**	
	A	Hepato and Renal Toxicology	CO3/CO6
	B	Developmental Toxicology and Immunotoxicology	CO3/CO6
	C	Organic Pollutants and Inorganic Pollutants	CO3/CO6
	Unit 4	**Environmental Nanotoxicology**	
	A	Nanoparticles in environment and its fate	CO4/CO6
	B	Toxicological and eco-toxicology	CO4/CO6
	C	Exposure and threat of nanoparticles	CO4/CO6
	Unit 5	**Environmental Health**	
	A	Global and regional perspectives of environmental health	CO5/CO6
	B	Human exposure and health impact	CO5/CO6
	C	Environmental diseases	CO5/CO6

	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Ware, George M.(Ed) (2007) Reviews of environmental contamination and toxicology. Vol. 190: Continuation of residue reviews, Springer Publishers			
	Other References	1. Tatiya, Ratan raj (2013) Elements of industrial hazards: Health, safety, environment and loss prevention Taylor and Francis. 2. Theodore, Louis (2012) Environmental health and hazard risk assessment: Principles and calculations, CRC Press 3. Wong, Ming H. (Ed.) (2013) Environmental contamination: Health risks and ecological restoration, CRC press 4. Manahan, Stanley E. (2013) Fundamentals of environmental and toxicological chemistry: Sustainable sciences, CRC press			

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	3	1	1	2
CO2	2	1	2	2	2	1	1	2
CO3	2	1	2	2	3	1	1	1
CO4	3	1	2	2	2	1	1	2
CO5	3	1	3	3	3	1	1	1

CO6	3	1	3	3	3	1	1	2

-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

2.4 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: II**
1	Course Code	MWE108
2	Course Title	**Glaciology and Climate Change**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Understanding of various concepts related with glaciers, characteristics features and global importance of glaciers. 2. Understanding of important glaciological features. 3: Provide a thorough concept on methods employed for glaciological measurements. 4: Understanding of glaciological hydrology through modelling 5: Enable to comprehend the concept of climate change with special reference to glacier as indicator 6: Overall this course helps in-depth understanding of various glaciological related process, features and events.
6	Course Outcomes	CO1:Concept of glaciers, its types, characteristics and importance. CO2: Knowledge of various features formed due to glaciers CO3: Concept of various techniques employed for glaciological measurements CO4: Concept related to glacier hydrology with the help of various model. CO5: Knowledge of climate change through monitoring of glacier as an indicator CO6: Overall understanding of glacier related processes and

		formations.	
7	Course Description	To develop basic understanding of glaciological process and various technical aspects related to glaciology.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Definition of glacier and types of glaciers; Process of formation of a glaciers	CO1/CO6
	B	Snow, firn and ice; crystallization of ice; glacier distribution on the globe, importance of glacier	CO1/CO6
	C	Himalayan glaciers and their characteristic features, regional and global importance of glaciers	CO1/CO6
	Unit 2	**Glaciological features**	
	A	Different zones in a glacier; Equilibrium line, accumulation area ratio and its importance	CO2/CO6
	B	Snout, bergschrund, moulin or glacier mill, supra-glacial and sub-glacial lakes, crevasses, debris cover, glacier table	CO2/CO6
	C	Glacial deposits,; Moraines and its types; Glacier velocity; Flow of valley glaciers and concept of glacier surges	CO2/CO6
	Unit 3	**Glaciological measurements**	
	A	Definition and concept of mass balance; Methods of mass balance measurements- In-situ measurement	CO3/CO6
	B	Remote sensing methods, Hydrological methods ; Mass Balance gradients	CO3/CO6
	C	Annual mass balance cycles, Mass balance of ice sheet	CO3/CO6
	Unit 4	**Glacier Hydrology**	

	A	Glacier melt water system; Glacio-hydrological modelling- Purposes and types			CO4/CO6
	B	Glacier mass balance model, energy balance model, Temperature index models			CO4/CO6
	C	Discharge measurement method, diurnal and seasonal variation			CO4/CO6
	Unit 5	**Climate Change and Glaciers**			
	A	Glacier as indicator of climate change; Impacts of Climate Change on Cryosphere; Impacts of climate change on glacier, permafrost and glacial lake			CO5/CO6
	B	Impacts of climate change hydrology of glacierized river basin			CO5/CO6
	C	Impacts on water resources of India, Socio-economic impacts. Glacial hazards and concept of GLoF			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Ware, George M.(Ed) (2007) Reviews of environmental contamination and toxicology. Vol. 190: Continuation of residue reviews, Springer Publishers			
	Other References	1. Physics of glacier, Fourth edition, 2011, Kurt M. Cuffey, W. S. B. Paterson, Elsevier. 2. Fundamentals of Glacier Dynamics, Second edition, 2013, C.J. Van der Veen, CRC press, Taylor & Francis Group, 3. Glaciers and Glaciation, 2010, 2nd edition Douglas Benn andDavid J A Evans, Hodder Arnold Publication			

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	2	3	1	1	2
CO2	2	1	1	1	2	1	1	2
CO3	2	1	2	1	2	1	1	1
CO4	2	1	2	2	3	1	1	2
CO5	2	1	2	2	3	1	1	1
CO6	2	1	2	2	3	1	1	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

2.5 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: II**
1	**Course Code**	MWE112
2	**Course Title**	**Remote Sensing Techniques & GIS**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1.Detailed understanding of principles of remote sensing 2. Understanding of concepts and various components of GIS along with its advantages and disadvantages 3: Provide a thorough concept on interpretation GIS database 4: Detailed understanding of Photogrammetry & Cartography 5: Application of remote sensing in natural hazards 6: Overall this course helps in-depth understanding of various components of remote sensing and application in the management of natural hazards.
6	Course Outcomes	CO1: Describe the concept of remote sensing and principle behind the same. CO2: Principles of GIS CO3: Use GIS and its different components for application in case studies CO4: Describe the concept of Photogrammetry & Cartography CO5: Remote Sensing Application in natural hazards CO6: Overall understanding of various components of remote sensing and application natural hazards management.

7	Course Description	To develop an understanding of geoinformatics, its principle, tools and techniques and application different fields of environmental science	
8	Outline syllabus		CO Mapping
	Unit 1	**Principles of remote Sensing**	
	A	Electromagnetic Radiation and Electromagnetic Spectrum, Interaction with the Atmosphere and radiation target	CO1/CO6
	B	Passive & Active Remote Sensing, Aerial Photographs and Satellite based Remote Sensing, Digital Image Processing and Interpretation	CO1/CO6
	C	Platforms and RS Data Acquisition Systems, Microwave Thermal Remote Sensing	CO1/CO6
	Unit 2	**Principles of GIS**	
	A	Basic Concepts: definition and component of GIS,	CO2/CO6
	B	Areas of GIS application, GIS Data and Data Structures.	CO2/CO6
	C	Advantage and Limitation of GIS	CO2/CO6
	Unit 3	**GIS Database**	
	A	Creating GIS Database-GIS Software, file organization and formats	CO3/CO6
	B	Method of spatial data capture	CO3/CO6
	C	Editing of data	CO3/CO6
	Unit 4	**Photogrammetry & Cartography**	
	A	Classification of aerial photographs. Scale of aerial photographs on uniform and variable terrain. Geometry of aerial photographs. Types of aerial mosaics and their advantages	CO4/CO6
	B	History and evolution of 2D and 3D imaging systems on Indian and foreign satellites Epi-polar registration	CO4/CO6

		of stereo images, Digital feature extraction and matching techniques for stereo image analysis.	
	C	Use of GPS and SAR interferometry data in 3D mapping, Cartographic problems of mapping the earth with horizontal and vertical controls, Reference Surfaces, Geoid and ellipsoid definitions, Map Projections and their properties, Hardware and software components of digital mapping systems.	CO4/CO6
	Unit 5	**Application of Remote Sensing in Natural Hazards**	
	A	Natural hazards: Concept of natural hazard. Types and classification of natural hazards: Causes, effects, monitoring, management of Earthquakes, Volcanic eruptions, Tsunamis.	CO5/CO6
	B	Role of remote sensing in monitoring and damage assessment. History of natural hazards in India.	CO5/CO6
	C	Vulnerable states and regions of India. Vulnerability index of various natural hazards in India. Preventive measures. Earthquake and Tsunami warning system in India.	CO5/CO6
	Mode of examination	Theory	
	Weightage Distribution	CA / MTE / ETE	
		30% / 20% / 50%	
	Text book/s*	1. Asrar Ghassem Theory and applications of optical remote sensing New York: John Wiley and Sons. 2. Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press. 3. Curran P.J., Principles of Remote Sensing, UK, ELBS.	
	Other References		

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	2
CO2	2	1	1	1	2	2	1	2
CO3	2	1	2	1	2	2	1	1
CO4	2	1	2	2	3	2	1	2
CO5	2	1	2	2	3	2	1	1
CO6	2	1	2	2	3	2	1	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

3.1 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**	
Program: MSc		**Current Academic Year: 2019-20**	
Branch: Water Resources and Environmental Management		**Semester: III**	
1	**Course Code**	MWE201	
2	**Course Title**	**Environmental Impact and Risk Assessment**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. Understanding of basic concepts, scope and purpose of EIA. 2. To provide knowledge on various methodologies employed for conducting EIA. 3. Provide a thorough concept on auditing and mitigation methods 4. Understanding of various elements of environmental risk assessment 5. Knowledge on emergency preparedness plan 6. Overall in-depth understanding of various components of EIA and risk assessment.	
6	Course Outcomes	CO1: EIA origin, concept, plans and case studies CO2: Steps and methods of EIA CO3: Monitoring, Mitigation and audit CO4: Methods for risk assessment, management plans and case studies CO5: Occupational health hazards and policies and emergency preparedness CO6: Overall understanding of various components of EIA and risk assessment.	
7	Course Description	To develop an understanding about EIA concepts and Methodologies, risk assessment, emergency preparedness and management plan	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to EIA**	
	A	Definition , scope and development of EIA, purpose, objectives and basic principles of EIA,	CO1/CO6
	B	Types of EIA, Strategic environmental assessment(SEA); History of EIA in India - EIA Gazette Notification, 1994 & 2006	CO1/CO6
	C	Category A & Category B Projects, Prior Environment	CO1/CO6

		clearance(EC) requirements and stages, General EIA methodology			
	Unit 2	**EIA methodology**			
	A	Screening- criteria, siting guidelines, prohibited zones; Scoping,			CO2/CO6
	B	Impact Identification -Checklists, matrices, qualitative methods, networks and overlay maps;			CO2/CO6
	C	Impact prediction- prediction models for impacts on air, water, soil and biological environment , Cost benefit analysis, Social impact assessment			CO2/CO6
	Unit 3	**Impact mitigation, monitoring & audit**			
	A	Mitigation methods and approaches, Appraisal, review, Decision making,			CO3/CO6
	B	Public consultation and participation, monitoring and auditing in EIA process, various forms of audit,			CO3/CO6
	C	Environment management plan (EMP), Environmental Impact Statement (EIS), Post-clearance Monitoring Protocol. Case studies: EIA of thermal power plant, mining.			CO3/CO6
	Unit 4	**Environmental Risk assessment**			
	A	Sources of Environmental hazards, Environmental risk assessment framework			CO4/CO6
	B	Path to risk analysis; Perception of risk, risk assessment in different disciplines.			CO4/CO6
	C	Elements of Environmental Risk Assessment, Methods for Risk Assessment: HAZOP and FEMA methods,			CO4/CO6
	Unit 5	**Risk management**			
	A	Risk communication and Risk Perception, comparative risks,			CO5/CO6
	B	Risk based decision making, Risk based environmental standard setting, , Emergency Preparedness Plans,			CO5/CO6
	C	Design of risk management programs, risk based remediation.			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	Environmental Management: Principles & Practices, Christopher J. Barrow, Routledge, 1999 - Business & Economics Handbook of Environmental Impact Assessment Vol. I and II, J. Petts, Blackwell Science, London, 2010.			
	Other References	Canter R.L., Environmental Impact Assessment, Mc Graw Hill International Edition, 1997 John G. Rau and David C. Wooten (Ed), Environmental			

		Impact Analysis Handbook, McGraw Hill Book Company.	

Pos COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1
CO2	2	1	1	1	2	3	1	1
CO3	2	1	2	1	2	3	1	2
CO4	2	1	2	2	3	2	1	2
CO5	2	1	2	2	3	2	1	2
CO6	2	1	2	2	3	3	1	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

3.2 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: III**
1	**Course Code**	MWE202
2	**Course Title**	**Water Purification and Treatment Processes**

3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	6. The concepts, and importance of wastewater treatment 7. Various techniques involved in wastewater treatment 8. Basics of designing of treatment plant 9. Various strategies for wastewater reuse and recovery 10. Suitable treatment plant for specific industries 11. Overall understanding of the basic concept and principles of water and wastewater treatment	
6	Course Outcomes	CO1.Objective, design and treatment of water and wastewater CO2.Types of wastewater treatment methods CO3. Biological treatment methods CO4. Advanced wastewater treatment methods CO5. Energy recovery and wastewater reuse and recovery CO6. Overall understanding of the basic concept of wastewater treatment and various techniques employed for its reclamation	
7	Course Description	To develop an understanding of the various methods of water and wastewater treatment and basics of designing a treatment plant.	
8	Outline syllabus		CO Mapping
	Unit 1	**Water treatment and Characterization of Wastewaters**	
	A	Objectives of wastewater treatment	CO1/CO6
	B	Design of waste water treatment	CO1/CO6
	C	Types of wastewater treatment plants	CO1/CO6
	Unit 2	**Waste Water Treatment**	
	A	Physical Treatment	CO2/CO6
	B	Chemical Treatment	CO2/CO6
	C	Membrane Filtration	CO2/CO6
	Unit 3	**Biological Wastewater Treatment, Recycling and Reusing**	

	A	Types of biological treatment			CO3/CO6
	B	Aerobic treatment			CO3/CO6
	C	Anaerobic treatment			CO3/CO6
	Unit 4	**Advanced Wastewater Treatment**			
	A	Nutrient removal			CO4/CO6
	B	Photocatalysis, ozonation and bioreactors			CO4/CO6
	C	Energy recovery			CO4/CO6
	Unit 5	**Wastewater Reuse and Recovery**			
	A	Treatment reuse and recovery			CO5/CO6
	B	Case studies of various industry types			CO5/CO6
	C	Zero liquid discharge			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	Jain S.K. and Singh V.P. (2006). Water Resources Systems Planning and Management, Reed Elsevier India Pvt. Ltd., New Delhi.			
	Other References	Larry M. (2003). Urban Storm Water Management Tools, McGraw Hill Publication.			

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	2	2	2	2
CO2	2	2	3	2	2	3	2	2

CO3	2	2	2	3	2	3	1	2
CO4	2	2	2	3	3	2	1	2
CO5	2	2	2	3	3	2	1	2
CO6	2	2	3	3	3	3	2	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

3.3 Template: Syllabus for Theory Subjects

School: SBSR		**Batch : 2019-21**
Program: MSc		**Current Academic Year: 2019-20**
Branch: Water Resources and Environmental Management		**Semester: III**
1	**Course Code**	MWE203
2	**Course Title**	**Research Methodology**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Understanding of various elements of research. 2. Enable to understand the concept of qualitative and quantitative research. 3. Thorough understanding of statistical approach in research 4. Understanding of computer application in research 5. Impart knowledge on thesis writing and various ethical issues related to publishing.
6	Course Outcomes	CO1: Research and hypothesis CO2: Qualitative and Quantitative research CO3: Concept and levels of measurements CO4: Basics of statistics CO5: Basics of software in research CO6: Overall understanding on various aspects of research and related areas.

7	Course Description	To develop an understanding of methods and various tools applied in research	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to research**	
	A	Foundations of Research, Concept of theory Concept of theory.	CO1/CO6
	B	Characteristics of scientific method – Understanding the language of research.	CO1/CO6
	C	Hypothesis Testing – Logic & Importance, Concept and Importance in Research, Exploratory Research Design, Experimental Design.	CO1/CO6
	Unit 2	**Qualitative and Quantitative Research**	
	A	Qualitative and Quantitative Research,	CO2/CO6
	B	Concept of measurement	CO2/CO6
	C	Levels of measurement	CO2/CO6
	Unit 3	**Statistical Research**	
	A	Sampling, Characteristics of a good sample,	CO3/CO6
	B	Probability Sample, Determining size of the sample,	CO3/CO6
	C	Data Analysis, Bivariate analysis.	CO3/CO6
	Unit 4	**Computer Applications**	
	A	Spreadsheet tools	CO4/CO6
	B	Presentation tools	CO4/CO6
	C	Web search tools	CO4/CO6
	Unit 5	**Writing thesis and ethics**	
	A	Interpretation of Data and Paper Writing, Layout of a Research Paper.	CO5/CO6
	B	Journals in Computer Science, Impact factor of	CO5/CO6

		Journals, When and where to publish?			
	C	Ethical issues related to publishing, Plagiarism and Self-Plagiarism.			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	C. R. Kothari, Research Methodology: Methods and Techniques, New Age Publication.			
	Other References				

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	3	1	1	1
CO2	2	2	3	2	3	2	1	1
CO3	2	2	2	2	3	2	1	1
CO4	2	2	2	2	3	2	1	1
CO5	2	2	2	2	3	2	1	1
CO6	2	2	3	2	3	2	1	1

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

3.4 Template: Syllabus for Theory Subjects

School: SBSR		Batch : 2019-2021	
Program: MSc		Current Academic Year: 2019-2020	
Branch: Water Resources and Environmental Management		**Semester: I**	
1	Course Code	MWE-205	
2	Course Title	**Water, Sanitation and Health**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. An introduction about the various sources of drinking water. 2. To understand the various sources of water pollution. 3. To understand the importance of clean water in respect to human health. 4. To understand the role of climate change in the evolvement of human pathogens in water. 5. To get deep understanding about waste water treatment	
6	Course Outcomes	CO1: Students will have an understanding about water CO2: Knowledge water pollution CO3: Concept of clean water and its importance for human health. CO4: Concept of climate change and its impact on water quality CO5: Deep understanding about waste water treatment technologies CO6: Overall understanding of water, its importance in respect to human health and waste water treatment.	
7	Course Description	To develop understanding of various concepts related to ground water and its management.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Understanding the significance of the environment for human health. Human population pressures and pollution dynamics.	CO1/CO6
	B	Common terms and definitions in water quality; Aquatic resources of the world & Sources of drinking water;	CO1/CO6
	C	Common contaminants of drinking water and linkages to disease.	CO1/CO6
	Unit 2	**Sources of Pollution**	
	A	Point and Non-point source pollution.	CO2/CO6
	B	Agricultural runoff. TMDLs.	CO2/CO6

	C	Best management practices (BMPs). Numeric vs. narrative standards			CO2/CO6
	Unit 3	**Water and Health**			
	A	Drinking water quality; Urban water sources and water treatment; Rural water sources and water treatment			CO3/CO6
	B	Types of sanitation facilities; Construction of sanitation facilities; Use of sanitation facilities; Waste water treatment; Refuse/rubbish collection and disposal			CO3/CO6
	C	Composting and agricultural use of human waste; Essential hygiene practices; Assessing hygiene practices in the field			CO3/CO6
	Unit 4	**Climate Change and Water quality**			
	A	Climate change			CO4/CO6
	B	water and climate change,			CO4/CO6
	C	how does it Change the Dynamics of Human Pathogens in Water?			CO4/CO6
	Unit 5	**Water and Wastewater Treatment for Development**			
	A	Water Quality & Public Health, Drinking Water, Chemicals & Health, Water Treatment Principles			CO5/CO6
	B	Water Treatment Challenges, Advanced Technologies in Water Treatment for Development, Community Considerations for Appropriate Water Treatment, Introduction to Wastewater Treatment, Low Energy Wastewater Treatment			CO5/CO6
	C	Advanced Technologies in Wastewater Treatment for Development, Resource Recovery from WS&S Technologies – Nutrients & Water, Resource Recovery from WS&S Technologies – Energy, Appropriate Technology Selection			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	Todd, D.K., and Mays, L. W., Groundwater Hydrology, John Wiley & Sons			

	Other References	1. Davis, S.N., and De Weist, R.J.M., Hydrogeology, John Wiley & Sons, New York. 2. Karamouz, M, Ahmadi, A, and Akhbari, M, Groundwater Hydrology: Engineering, Planning and Management, CRC Press.	

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2	2	3
CO2	3	3	2	2	2	2	2	2
CO3	3	2	2	2	1	2	2	2
CO4	3	2	3	2	2	2	2	2
CO5	3	2	3	2	2	2	2	2
CO6	3	2	2	2	2	3	1	3

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

4.1 Template: Syllabus for Theory Subjects

School: SBSR		Batch : 2019-2021
Program: M.Sc.		Current Academic Year: 2019-2020
Branch: M.Sc. in Water Resources and Environmental Management		Semester: IV
1	Course Code	MWE-206
2	Course Title	**Ground water quality and management**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Various groundwater related parameters and concepts. 2. To introduce about aquifers characteristics, types and its dynamics 3: Provide a thorough concept on ground water storage, recharge and flow and importance 4: Understanding of salt water intrusion and impact assessment of ground water quality due to developmental project 5: Enable to comprehend the concept of ground water quality, factors affecting its quality, pollution problem and remediation 6: Overall this course helps in-depth understanding of various ground water related parameters its quality and management.
6	Course Outcomes	CO1:Concept of groundwater and related hydrological parameters CO2: Knowledge of aquifers, its types, and availability in different geological region CO3: Concept of ground water recharge, laminar and turbulent flow and various factors governing ground water flow. CO4: Concept related to sea water intrusion and impact assessment of development project CO5: Concept of groundwater pollution, its analysis and remediation CO6: Overall understanding of ground water quality concepts and its management.

7	Course Description	To develop understanding of various concepts related to ground water and its management.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Ground water utilization & historical background	CO1/CO6
	B	Ground water in hydrologic cycle, ground water budget,	CO1/CO6
	C	Ground water level fluctuations & environmental influence	CO1/CO6
	Unit 2	Hydrogeological parameters	
	A	Unconsolidated aquifers, Lithified sedimentary rocks, Igneous and Metamorphic rocks,	CO2/CO6
	B	Groundwater in permafrost region, Groundwater in desert, coastal and Plain areas,	CO2/CO6
	C	Types of aquifers, perched, unconfined, semi-confined and confined aquifers.	CO2/CO6
	Unit 3	**Hydraulics**	
	A	Storage co-efficient of aquifer, ground water recharge, specific retention, Specific yield, porosity, permeability, method of determination of specific yield	CO3/CO6
	B	Darcy's law: Darcy's law in terms of Force and Potential. The applicability of Darcy's law. Specific discharge, laminar flow and turbulent flow.	CO3/CO6
	C	Water Harvesting: Types of storage structures, water yield from catchments, runoff diversion, pond and reservoirs, earth embankments, artificial recharge of ground water.	CO3/CO6
	Unit 4	**Groundwater conservation**	
	A	Occurrence of saline water intrusion, relation to fresh water, shape of fresh and salt water interface	CO4/CO6

		upcoming of saline water	
	B	Environmental impact assessment: Methods of site selection, site evaluation for Engineering purposes. Dams, Tunnels, Highways, Airports, large building. Ground water and foundation problems of bridges.	CO4/CO6
	C	Environmental impact of water impoundment, Dams and Environment, Hazards in snowy mountains, Surface and sub surface investigation of ground water.	CO4/CO6
	Unit 5	**Ground water quality**	
	A	Ground water pollution, quality analysis of ground water, municipal, industrial, agricultural, miscellaneous sources & causes of pollution and remediation	CO5/CO6
	B	Physical, chemical and biological analysis of ground water quality, criteria & measures of ground water quality, ground water salinity & samples, graphical representations of ground water quality	CO5/CO6
	C	Case studies, Ground water contamination due to arsenic, fluoride, nitrate.	CO5/CO6
	Mode of examination	Theory	
	Weightage Distribution	CA / MTE / ETE 30% / 20% / 50%	
	Text book/s*	1. Todd, D.K., and Mays, L. W., Groundwater Hydrology, John Wiley & Sons	
	Other References	1. Davis, S.N., and De Weist, R.J.M., Hydrogeology, John Wiley & Sons, New York. 2. Karamouz, M, Ahmadi, A, and Akhbari, M, Groundwater Hydrology: Engineering, Planning and Management, CRC Press.	

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1	1	1	1
CO2	2	2	2	2	1	1	1	1
CO3	2	2	2	2	1	1	2	1
CO4	2	1	3	2	2	2	2	1
CO5	3	1	3	2	2	1	1	2
CO6	3	1	2	2	2	3	1	3

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

4.2 Template A1: Syllabus for Theory Subjects

School: SBSR		Batch : 2019-2021
Program: MSc		Current Academic Year: 2019-2020
Branch: MSc in Water Resources and Environmental Management		Semester: IV
1	Course Code	MWE 207
2	Course Title	Industrial Waste water treatment
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Elective
5	Course Objective	1. To make the students knowledgeable with respect to the subject and it practicable applicability. 2. To promote understanding of basic and advanced concepts in Industrial pollution aspects and waste water treatment technologies. 3. To expose the students to different processes used in industries and in research field. 4. To develop skills required in various industries, research labs and in the field of human health. 5. To prepare the students to accept the challenges in industrial sectors. 6: Overall this course helps in-depth understanding of various techniques used for treating industrial waste water
6	Course Outcomes	CO1:Concept of water quality and standards CO2: Understanding of various chemical and physical treatment process for industrial wastewater CO3: Understand the concept of sanitation system and wastewater microbiology CO4: Understanding the functioning of various unit process and advance water treatment technique CO5: Understanding of treatment techniques employed for various industries. CO6: Overall understanding of various industrial wastewater treatment procedure and techniques

7	Course Description	To develop understanding of various concepts related to industrial waste water treatment.	
8	Outline syllabus		CO Mapping
	Unit 1	**Water Supply**	
	A	Sources, Water Demand and Forecasting,	CO1/CO6
	B	Quality of Water, Water Borne Diseases, Standards	CO1/CO6
	C	Water Quality Index, Water Pollution Sources and Control.	CO1/CO6
	Unit 2	**Physical and Chemical Process of Waste Water Treatment**	
	A	Physical Process - Flow, Screens, Reactors, Mixing and Flocculation	CO2/CO6
	B	Sedimentation, Filtration. Chemical Process - Coagulation/Softening	CO2/CO6
	C	Iron and Manganese Removal, Disinfection, Miscellaneous Processes	CO2/CO6
	Unit 3	**Wastewater Engineering**	
	A	Systems of Sanitation, Wastewater Flows, Collection and Conveyance of Wastewater	CO3/CO6
	B	Layout Systems. Characteristics and Microbiology of Wastewater, BOD Kinetics	CO3/CO6
	C	Disposal of Treated Wastewater on Land and in Water	CO3/CO6
	Unit 4	**Treatment Processes and Flow-Sheets**	
	A	UNIT Operations and UNIT Processes, Wastewater Flow Rates and Their Assessment/Measurement, Primary Treatment	CO4/CO6
	B	Biological UNIT Processes - Nature and Kinetics of Biological Growth, Aerobic Activated Sludge Process and Its Various Modifications	CO4/CO6
	C	Aerobic Activated Lagoons Stabilisation Ponds; Tricking Filters, Roughing Filters, Rotating Biological Contractors, Expanded Bed and Sequential Batch Reactors. Sludge Disposal.	CO4/CO6
	Unit 5	**Treatment of selected Industrial waste water**	
	A	Sources, Characteristics, effect of waste on receiving	CO5/CO6

		water and sewer, waste treatment flow sheets.			
	B	Treatment of industrial waste water Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper.			CO5/CO6
	C	Distilleries, Steel plants, Refineries, fertilizer, thermal power plants, Wastewater reclamation concepts.			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. M. N. Rao & A. K. Dutta, "Wastewater Treatment", Oxford - IBH Publication. 2. W .W. Eckenfelder Jr., "Industrial Water Pollution Control", McGraw-Hill Book Company, New Delhi.			
	Other References	1. T. T. Shen, "Industrial Pollution Prevention", Springer. 2. R. L. Stephenson and J. B. Blackburn, Jr., "Industrial Wastewater Systems Hand book", Lewis Publisher, New Yark. 3. H. M. Freeman, "Industrial Pollution Prevention Hand Book", McGraw-Hill Inc., New Delhi.			

POs COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	2	2	2	2
CO2	2	2	3	2	2	3	2	2
CO3	2	2	2	3	2	3	1	2
CO4	2	2	2	3	3	2	1	2
CO5	2	2	2	3	3	2	1	2

CO6	2	2	3	3	3	3	2	2

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)