Sant Gadge Baba Amravati University, Amravati

Faculty: Science and Technology

Programme: PGDWTM (Post Graduate Diploma in Watershed Technology and Management)

PROGRAMME OUTCOMES (POs)

PO1	Deep subject Knowledge and intellectual breadth	Developed extensive subject knowledge in various field of Watershed Management.
PO2	Professional Ethics	Apply ethical principles and commit to professional ethics are dedicated to the highest standards of personal integrity and professional conduct.
PO3	Creative & Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO4	Innovation, Research and Problem Solving	Identify, create and review research materials to solve complex problems that lead to concentrate and innovative conclusion. Apply the knowledge to solve problems associated with Watershed Management. Design solutions for complex problems with appropriate consideration for the watershed management, groundwater exploration, water scarcity, soil and water conservation, rain water harvesting, water quality etc.
PO5	Team work and Communication Skills	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings Present/communicate research at national/international level, write effective articles, reports and design documentation, make effective presentations, and give and receive clear instructions. Communicate disciplinary knowledge to the community and broader public.
PO6	Professionalism and Leadership Readiness	Demonstrate personal accountability and effective work habits, e.g., time and work planning as well as punctuality and working productively with different components. Use the strengths of others to achieve common goals.
PO7	Lifelong learning	Watershed Management enables you to think at a higher level and act locally as individual and as citizens you need to be aware of the nature around you as well as to make the right decisions about the environment and the important elements of nature.
PO8	Global Citizenship	Act with an informed awareness of global issues. Engage in initiatives that encourage equity and growth for all.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the one-year PGDWTM (Post Graduate Diploma in Watershed Technology and Management) programme, the student would be able to:

PSO 1: By completing assignments, participating in seminars, and working on projects, students can demonstrate their proficiency in basic watershed related problem-solving abilities, such as the ability to identify different water scarcity zones and to think critically. Develop a culture of research work, and improve the understanding of watershed management for the socio-economic and sustainable development.

PSO 2: To solve problems, share advanced information on subjects related to many aspects of Watershed Management, such as water scarcity, water quality, crop productivity, rain water harvesting, soil and water conservation.

PSO 3: Collaborate with various watershed management related organization with demonstration of true values of leadership, co-operation, hard work, teamwork etc. during the field visits, field works and surveys during watershed development programs.

Employability Potential of the Programme:

Post Graduate Diploma in Watershed Technology and Management (PGDWTM) is a postgraduate diploma course of one year duration, divided into two semesters. This course basically teaches students about the watershed technology and management with focus on the scientific study of water quality and its uses for the socio-economic development of the society and also enhances the crop productivity, fodder, sustainable use of natural resources as well as creates employability.

Post Graduate Diploma in Watershed Technology and Management programme is developed to create the awareness about issues related to the water, natural resources, environmental protection, soil and water conservation, artificial recharge and rain water harvesting also use of modern technology like remote sensing and GIS for the integrated watershed development. The programme would also develop the problem solving ability of the student in the area of forest, environment, wasteland management and natural hazards like floods, landslides, etc.

Watershed development programmes have potential to create employment opportunities on temporary as well as permanent basis. If maintenance programmes are taken up as envisaged in the technical plan of the watershed development programme, it is possible to further improve the employment opportunities, which will help to stabilize annual incomes of the landless in particular and farming community in general. On the basis of various estimates of labour availability and utilization, the employment potentials of rural region can be further boosted.

After completing the PGDWTM course, the students can work for NGO's, Government organization and educational institution. They can get jobs as a watershed management expert, water explorer. The students can also start own consulting firm in the areas of ground water exploration, rain water harvesting and artificial recharge. The students also have the opportunity to develop own business for water exploration, quality water supply and watershed development planner.

Nowadays water scarcity is one of the major problems in the society and only watershed management expert can find the solution on this issue. Watershed management contributes a lot of innovation in fields like agriculture, agroforestry, flood management, soil and water conservation, water quality and its uses, artificial recharge of water and rain water harvesting.

In India several Ministries namely, Ministry of Agriculture, Ministry of Rural Development and Ministry of Environment and Forests have been involved in Watershed Development Programs with substantial variation in their approaches. The Ministry of Rural Development had been coordinating sector-wise flagship schemes such as IWDP, DPAP and DDP under Watershed Development Programmes. The main objective of the WDP was to improve water conservation, irrigation facility, and land use pattern leading to increased agricultural productivity in drought prone and desert prone areas. Poverty reduction, better livelihoods and improved bio-physical and socioeconomic environment would bring about sustainable development.

Job opportunities

1) **Central government companies and PSUs**
   Central Ground Water Board **(CGWB)**, Regional Remote Sensing Centre **(RRSC)**, National Remote Sensing Centre **(NRSC)**, National Environmental Engineering Research Institute **(NEERI)**.
2) **State government**
   Groundwater Surveys & Development Agency **(GSDA)**, Maharashtra Remote Sensing Application Centre **(MRSAC),** Agriculture department, Disaster management, Department of soil conservation, Conservator of forest, Patbandhare Vibhag, Zillah Parishad, Block Development Office, Municipal Corporation and Nagar Panchayat
3) **Multinational companies, Private sector and NGO's**

   Thermax India. GE Water. Siemens India- Water Technologies. Aqua Innovative Solutions. Voltas Limited. Hindustan Dorr-Oliver Limited. UEM India Pvt Ltd. SFC Environmental Technologies Private Limited.

   Environmentalist Foundation of India (EFI), Tarun Bharat Sangh**,** SARA (Sustainable

Alternatives for Rural Accord), Jal Bhagirathi Foundation, Sehgal Foundation, Dreams Alive, Centre for Aquatic Livelihood Jaljeevika, Watershed Organisation Trust (WOTR), Self Reliant Initiatives through Joint Action (SRIJAN), Sankalpa Rural Development Society.

Bhumi, Swades, Watershed Organisation Trust (WOTR), Gramin Vikas Vigyan Samiti, Navjyoti India Foundation.

APPENDIX-A

Sant Gadge Baba Amravati University, Amravati

Scheme of Teaching, Learning & Examination leading to the Post Graduate Diploma in Science (One Year- Two Semesters Post Graduate Diploma Course C.B.C.S)

Semester- I, PGDWTM (Post Graduate Diploma in Watershed Technology and Management)

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme			.Examination & Evaluation Scheme							Total
						Theory				Practical			
			T	P	Total Periods week	Duration of Exams Hrs	Maximum marks theory Papers	Total	Minimum Passing	Maximum marks	Total	Minimum Passing	
1	Fundamentals of Geology	1 WTM 1	04	--	04	03	50	50	20	-			50
2	Fundamentals of Watershed	1 WTM 2	04	--	04	03	50	50	20	-			50
3	Groundwater Hydrogeology and Geophysical Exploration	1 WTM 3	04	--	04	03	50	50	20	-			50
4	Remote Sensing and GIS applications in Watershed Management	1 WTM 4	04	--	04	03	50	50	20	-			50
5	LAB-1(General Geology and Watershed Management)	1 WTM 5		06	06	03	-	-	-	25	25	12	25
6	LAB-2 (Remote Sensing and GIS, Geophysical Exploration and Hydrogeology)	1 WTM 6		06	06	03	-	-	-	25	25	12	25
7	#Field Work												
8	Total		16	12	28								250

APPENDIX-A

Sant Gadge Baba Amravati University, Amravati

Scheme of Teaching, Learning & Examination leading to the Post Graduate Diploma in Science (One Year- Two Semesters Post Graduate Diploma Course C.B.C.S)

Semester- II, PGDWTM (Post Graduate Diploma in Watershed Technology and Management)

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme			.Examination & Evaluation Scheme							Total
						Theory				Practical			
			T	P	Total Periods week	Duration of Exams Hrs	Maximum marks theory Papers	Total	Minimum Passing	Maximum marks	Total	Minimum Passing	
1	**Watershed Hydrology**	**2 WTM 1**	**04**	**--**	**04**	**03**	**50**	**50**	**20**	-			50
2	**Introduction to Watershed Technology**	**2 WTM 2**	**04**	**--**	**04**	**03**	**50**	**50**	**20**	-			50
3	**Soil and Water Conservation**	**2 WTM 3**	**04**	**--**	**04**	**03**	**50**	**50**	**20**	-			50
4	**Watershed Development and Management**	**2 WTM 4**	**04**	**--**	**04**	**03**	**50**	**50**	**20**	-			50
5	**LAB-3 (Watershed Hydrology and Soil and water conservation)**	**2 WTM 5**		**06**	**06**	**03**	**-**	-	**-**	**25**	25	**12**	25
6	**LAB-4 (Project report)**	**2 WTM 6**		**06**	**06**	**03**	**-**	-	**-**	**25**	25	**12**	25
7	**Total**		**16**	**12**	**28**								**250**

Syllabus Prescribed for One Year (2023-24) Post PG Diploma Programme
Programme: PGDWTM (Post Graduate Diploma in Watershed Technology and Management)
Semester I

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1 WTM 1	**Fundamentals of Geology**	**60**
1 WTM 2	**Fundamentals of Watershed**	**60**
1 WTM 3	**Groundwater Hydrogeology and Geophysical Exploration**	**60**
1 WTM 4	**Remote Sensing and GIS applications in Watershed Management**	**60**
1 WTM 5	**LAB-1(General Geology and Watershed Management)**	**6 Hrs/Week**
1 WTM 6	**LAB-2 (Remote Sensing and GIS, Geophysical Exploration and Hydrogeology)**	**6 Hrs/Week**

COs (1 WTM 1): Fundamentals of Geology

1. Students would be able to explain the basics of minerals, rocks and its properties.
2. Students would be able to explain the different types of geomorphic processes and drainage patterns.
3. Students would be able to describe the different types of geomorphic landforms and its characteristics.
4. Students would be able to describe the geological structures like folds, faults, fractures, joints and unconformities.
5. Students would be able to explain the atmosphere, hydrosphere, lithosphere and their constituents.

Unit	Content
Unit I	Introduction of Geology: A brief history of the earth through geological time. Interior of the Earth. Minerals: Definition, physical properties. Rocks: Definition, types of rocks: Igneous, sedimentary and metamorphic. Structure, texture and classification of these rocks. **(12)**
Unit II	Geomorphology: Geomorphic processes, endogenic and exogenic. Weathering: Mechanical, chemical and biological weathering, drainage pattern and their significance. Drainage basin, morphometric and hypsometric analysis of drainage basin. **(12)**
Unit III	Geomorphic agents, erosional and depositional landforms produced by geomorphic agents: Fluvial, coastal, glacial and aeolian landforms and karst topography. **(12)**
Unit IV	Rock as layers (beds), their attitude. Geological structures like folds, faults, fractures joints and unconformities – their nomenclature, classification and recognition. Importance of these structures in groundwater exploration and water resource management.

(12)

Unit V	Atmosphere, hydrosphere, lithosphere and their constituents. Physiographic division of India, weather and climate. Precipitation: types, distribution, factors controlling distribution, seasonal variation and intensity of precipitation.

(12)

Course Material/Learning Resources

Essential Reading:

1. Kevin Helleran and John O'Brien (2010), **Earth materials,** John Wiley and Sons
2. Mahapatra G.B , **Textbook of Physical geology**, CBS Publ.
3. Lal D.S (2011), **Climatology,** Sharda Pustak Bhavan
4. Tyrell, G. W. (1963), **Principles of Petrology**, Metheun
5. Jain, S. (2014), **Fundamentals of Physical Geology**, Springer

Suggested Reading:

1. Gribble C. D. Rutley's **Elements of Mineralogy** 27th edition
2. Dexter Perkins (2015), **Mineralogy** 2nd ed Pearson education India, New Delhi
3. Park, R. G. (1989**), Fundamentals of Structural Geology,** Routledge.
4. Savindra Singh (2015), **Geomorphology**, Paravalika Publication

COs (1WTM 2): Fundamentals of Watershed

1. Students would be able to explain the basic concepts of watershed.
2. Students would be able to understand the irrigation water management and methods of water application to crop.
3. Students would be able to describe the afforestation, deforestation and agroforestry.
4. Students would be able to distinguish between arable and non-arable land, waste land and its management.
5. Students would be able to understand the guidelines of watershed development programs in India.

Unit	**Content**
Unit I	Watershed: Introduction, concept, principal, scope, coding, need, delineation, characterization, identification of watershed and its significance, objectives of watershed development, multidisciplinary approach for watershed management. Watershed causes of deterioration.

(12)

Unit II	Irrigation Water Management: Crop season, crop selection, crop rotation and irrigation schedule. Method of water application to crop: surface method, sprinkler method, drip method and subsurface method. Water conveyance and application method: lined and unlined canals.

(12)

Unit III	Afforestation in Watershed: Utility of forests, classification of forests, advantages of afforestation. Deforestation: Definition causes and impact. Agroforestry: Definition, objective, importance, benefits and conservation of natural resources through agroforestry.

(12)

Unit IV	Arable land: Introduction, agriculture and horticulture. Non- arable land: Introduction, forestry, fishery and animal husbandry. Wasteland, causes of wasteland: water logging, salinity, overgrazing, mining operation, industrial effluent, remedial measures in wasteland management.

(12)

Unit V	Guidelines of watershed development programs in India. Watershed based rural development. Urban watershed development: Goals and strategies. Selection of watershed development and management agency, case study. **(12)**

Course Material/Learning Resources

Essential Reading:

1. Das M. M. and Saikia M.D (2013), **Watershed Management,** PHI Learning Pvt. Ltd.
2. Khan M. A. (2006), **Watershed management for sustainable agriculture,** Agribios (India)
3. Murthy V. V. N. (2007), **Land and Water Management engineering**, Kalyani Publications.
4. Tideman, E.M., (1996), **Watershed Management: Guidelines for Indian Conditions,** Omega Scientific Publishers, New Delhi.

Suggested Reading:

1. Murthy J. V. S. (2006), **Watershed Management,** New Age International Publishers.
2. Dhruva Narayana V.V., Shastry G. and Patanaik U.S. (1997), **Watershed Management,** ICAR, New Delhi.

COs (1 WTM 3): Groundwater Hydrogeology and Geophysical Exploration

1. Students would be familiar with the main aspects of the groundwater and its availability.
2. Students would be able to understand the aquifer characteristics.
3. Students would be able to understand the different types of water qualities.
4. Students would be able to describe the quality criteria for groundwater supplies.
5. Students would be able to understand concept of the groundwater exploration.

Unit	**Content**
Unit I	Groundwater origin, types, importance. Groundwater occurrence: Vertical distribution of ground Water. Water bearing properties of rocks: Porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity and storage coefficient. Ground water flow-movement of ground water, Darcy's law and its validity. **(12)**
Unit II	Classification of rocks base on porosity and permeability: Aquifer, aquitard, aquiclude, aquifuge. Geological formations as aquifers. Types of aquifers: Confined, unconfined, semi-confined perched aquifer. Recharge of aquifer, artificial recharge, mode of occurrence of groundwater in different geological terrains of India. **(12)**
Unit III	Physical, chemical and bacteriological quality of water. Dissolved constituents in groundwater (major, minor and trace elements). Changes in the chemical compositions. Chemical processes occurring in groundwater-dissolution and precipitation. Adsorption and ion exchange, mixing, oxidation, reduction. **(12)**
Unit IV	Quality criteria for groundwater supplies: Drinking, domestic, irrigation, and industrial use. Pollution of surface and sub-surface water, its health hazards, water quality monitoring and preventive measures. Conjunctive and consumptive use of water.

(12)

Unit V	Groundwater exploration: Ground water prospecting, geological and surface geophysical methods for the selection of suitable site for well construction. Type and design of wells, methods of well construction, well completion and well development. Geophysical methods in ground water exploration: Basic principles, types, field procedure, profiling, interpretation of data and applications. **(12)**

Course Material/Learning Resources

Essential Reading:

1. Raghunath N.M. (1982), **Ground Water,** Wiley Eastern.
2. Eugene W. Rice, (2012), **Standard Method,** APHA Publisher.
3. Karanth, K.R. (1987), **Groundwater Assessment - Development and Management**. Tata Mc-Graw Hill.
4. Sharma P.V. (1986), **Geophysical Methods in Geology**, Elsevier.
5. Akhauri Sanjay and Akhauri H. M. (2015), **Fundamentals of Hydrogeology**, Zobra Books.

Suggested Reading:

1. Davies, S.N. and De Weist, R.J.M. (1966), **Hydrology**, John Wiley.
2. Freeze R.A. and Cherry J.A. (1979**), Ground Water,** Prentice Hall.
3. Fetter, C.W. (1990), **Applied Hydrogeology**, Merill Publishing.
4. Todd D.K. (1980), **Groundwater Hydrology**, John Wiley.

COs (1 WTM 4): Remote Sensing and GIS applications in Watershed Management

1. Students would be able to understand the basic concept of remote sensing.
2. Students would be able to explain the Photogrammetry.
3. Students would be able to describe geographical information system.
4. Students would be able to understand the application of remote sensing in watershed management.
5. Students would be able to explain the application of GIS in watershed management.

Unit	**Content**
Unit I	Introduction, principle, objectives and scope of remote sensing, electromagnetic spectrum and its characteristics. Components of remote sensing: platforms, sensors, orbits. Concept of spectral signatures: Rock, soil and water. **(12)**
Unit II	Photogrammetry: Arial photos and its type, scale, resolution, properties of aerial photos. Image elements: image characters and their relations with ground object in tone, colour, texture, pattern, shape, size shadow, site, association. Terrain elements: Drainage pattern. **(12)**
Unit III	Geographical information system (GIS): Definition, principals, components and its importance. Spatial data models: Vector and raster, data input and output, data acquisition, verification and editing, georeferncing, database design, structure and analysis. Digital elevation model (DEM image), LANDSAT-8 images. (**12)**
Unit IV	Water resource in land use and land cover analysis, land use/land cover: classification, principles, application, mapping, monitoring of surface, water bodies, tanks, lakes/reservoirs and regional planning. Remote sensing for lithological discrimination and geological mapping in

	watershed. **(12)**
Unit V	GIS as a watershed tool for developing a watershed management plan, GIS delineation of watershed, development of a watershed management plan, activity. GIS application in natural resources and its management: Evaluation, land, wetland, waste land and water resources. **(12)**

Course Material/Learning Resources

Essential Reading:

1. Gupta, R. P. (2003), **Remote Sensing Geology.** 2nd Springer-Verlag, Heidelberg.
2. Lillesand, T. M. and Kiefer R. (1987), **Remote Sensing and Image Interpretation**, John Wiley.
3. Pandey, S. N. (1987), **Principles and Applications of Photogeology**. Wiley Eastern Ltd., Delhi.
4. Burrough, P. A. (1986), **Principles of Geographic Information Systems for Land Resources Assessment**.
5. Reddy Anji M. (2008), **Remote Sensing and Geographic Information Systems.** BS Publications**.**

Suggested Reading:

1. Avery, T. U. and Berlin, G. L. (1992), **Fundamentals of Remote Sensing and Air Photo Interpretation**, McMillion Publishing Co., New York
2. Chandra A. M. (2006), Remote **Sensing & GIS**, Narosa Publising House. Delhi.
3. Miller, V. C. (1961), **Photogeology,** McGraw Hill Book Co., New York.

Activities:

1. Assignment/ Seminar
2. Class test
3. Field work
4. Visit to the various organization
5. Unnat Bharat Abhiyan/ Community Based Participatory Research (CBPR).

Weblink to Equivalent MOOC on SWAYAM

https://onlinecourses.swayam2.ac.in/cec21_mm01/preview

https://onlinecourses.nptel.ac.in/noc22_ce98/preview

https://onlinecourses.nptel.ac.in/noc22_ce44/preview

PRACTICALS

Syllabus Prescribed for One Year (2023-24) PG Diploma Programme

Programme: PGDWTM (Post Graduate Diploma in Watershed Technology and Management)

Semester I

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands-on/Activity)	No. of Periods/Week
1 WTM 5	**LAB-1(General Geology and Watershed Management)**	**06**
1 WTM 6	**LAB-2 (Remote Sensing and GIS, Geophysical Exploration and Hydrogeology)**	**06**

COs (1 WTM 5- General Geology and Watershed Management)

Students would be able to:

1. Understand toposheet reading.
2. Identify the megascopic properties of various rocks.
3. Prepare and interpret the watershed map.
4. Understand delineation of watershed using toposheet.
5. Understand watershed prioritisation.

*** List of Practical/Laboratory Experiments/Activities etc.**

1. Toposheet reading.
2. Megascopic identification of rocks.
3. Preparation of watershed map.
4. Delineation of watershed using toposheet.
5. Watershed prioritisation.

Reference Books:

1. Tyrell, G. W. (1963), **Principles of Petrology**, Metheun.
2. Das M. M. and Saikia M.D. (2013), **Watershed Management,** PHI Learning Pvt. Ltd.

COs (1 WTM 6- Remote Sensing and GIS, Geophysical Exploration and Hydrogeology)

Students would be able to

1. Interpret the satellite images.
2. Perform well inventory.
3. Calculate the average rainfall of watershed by thiessen polygon method.
4. Perform electrical resistivity survey.

List of Practical/Laboratory Experiments/Activities etc.

1. Visual interpretation of satellite imageries.
2. Well inventory.
3. Computation of average rainfall of watershed by Thiessen polygon method.

4. Electrical resistivity survey.

Reference Books:

1. Gupta, R. P. (2003), **Remote Sensing Geology,** 2nd Ed., Springer-Verlag, Heidelberg.
2. Pandey, S. N. (1987), **Principles and Applications of Photogeology**. Wiley Eastern Ltd., Delhi.
3. Nandipati Subba Rao (2016), **Hydrogeology Problem with Solution,** PHI learning private limited.

Syllabus Prescribed for One Year (2022-23) PG Diploma Programme

Programme: PGDWTM (Post Graduate Diploma in Watershed Technology and Management)

Semester II

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2WTM 1	**Watershed Hydrology**	**60**
2 WTM 2	**Introduction to Watershed Technology**	**60**
2 WTM 3	**Soil and Water Conservation**	**60**
2 WTM 4	**Watershed Development and Management**	**60**
2 WTM 5	**LAB-3 (Watershed Hydrology and Soil and water conservation)**	**6 Hrs/Week**
2 WTM 6	**LAB-4 (Project report)**	**6 Hrs/Week**

COs (2 WTM 1): Watershed Hydrology

1. Students would be able to understand the concept of hydrological cycle and its component.
2. Students would be able to explain the evaporation and infiltration processes in hydrological cycle.
3. Students would be able to describe the water yield and hydrographs.
4. Students would be able to explain the use of hydrological data in watershed planning.
5. Students would be able to understand the floods and its management.

Unit	Content
Unit I	Hydrologic cycle: Precipitation, evaporation, transpiration, infiltration, runoff. Estimation of water balance and its components. Precipitation: Forms and characteristics of precipitation, measurement of precipitation, mean precipitation over an area. Water budgeting. **(12)**
Unit II	Evaporation: Process, empirical evaporation equations, analytical methods of evaporation estimation. Transpiration, evapotranspiration, measurement of evapotranspiration. Infiltration: Infiltration capacity, measurement and runoff. **(12)**
Unit III	Water Yield: Concept, assessment and benefits. Hydrographs: Factors affecting hydrograph, components of hydrograph, base flow separation, effective rainfall. Unit Hydrograph: Derivation of unit hydrograph, unit hydrograph of different durations, use and limitations of unit hydrograph. **(12)**

Unit IV	Hydrologic Data in Watershed Planning: Use of hydro-meteorological data in watershed planning, use of hydro-meteorological data in hydrological characterization, flood management and control, irrigation and drainage, groundwater planning, water quality management.	**(12)**
Unit V	Floods: Introduction, types of flooding: According to duration (slow-onset flooding, rapid-onset flooding, flash flooding) and according to location (coastal flooding, mud flooding, river flooding, urban flooding), cause of flooding. Structure measure: Dam and reservoirs, embankments, channel improvement, river diversion, flood walls, sluice.	**(12)**

Course Material/Learning Resources
Essential Reading:

1. Raghunath N.M. (1982), **Ground Water,** Wiley Eastern.
2. Karanth, K.R. (1987), **Groundwater Assessment - Development and Management**. Tata Mc-Graw Hill
3. Reddy P. J. (2011), **A Textbook of Hydrogeology**, Laxmi pb. pvt.ltd.
4. Tolman, C. F. (1937), **Groundwater,** Mcgraw Hills Book co inc. New York and London
5. Subramanya K. (2008), **Engineering Hydrology.** The McGraw–hill company

Suggested Reading:

1. Sharma, R. K. (1979), **A tsext book of hydrology & water resources**, Dhanpatrai & Sons.
2. Walton, W. C. (1970), **Ground water resource evaluation,** McGraw Hills Book Co.

COs (2 WTM 2): Introduction to Watershed Technology

1. Students would be able to understand basic concept of watershed modelling.
2. Students would be able to understand the management of natural drainage in watershed.
3. Students would be able to describe basic concept of rainwater harvesting.
4. Students would be able to describe different methods of rainwater harvesting.
5. Students would be able to understand the rooftop rainwater harvesting and in-situ rainwater harvesting.

Unit	**Content**	
Unit I	Watershed Modelling: Introduction, data of watershed for modelling, history and evolution of watershed modelling, application of watershed model, comparison of watershed models, models calibration and validation, advanced of watershed models.	**(12)**
Unit II	Management of natural drainage in watershed: Introduction, Rivers bank management measures in watershed, River training works- objective of river training, classification of river training, Methods of river training works: Embankments (Levees or Dikes), Spurs (Groynes), artificial cut-off, guide banks, stream bank protection measure, and river training for sediment control.	**(12)**
Unit III	Rainwater harvesting: Definition, importance of rainwater harvesting, process of harvesting water, rainwater harvesting system, basic components of rainwater harvesting system, benefits of rainwater harvesting.	**(12)**
Unit IV	Traditional method of rainwater harvesting: Paar system, Talab, Saza kuva, Johad, Pat system, Naada, Rapat, Chandela tank, Khadin, Bamboo drip irrigation, Virdas. Modern method of rainwater harvesting: Artificial recharging, harvesting method, ground water dam, ferrocement technology.	**(12)**

Unit V	Rooftop rainwater harvesting: Development of rooftop harvesting, technical aspects, operation and maintenance, choice of roofing material and advantages. In situ rainwater harvesting: Use of in situ technology for crop production. Catchment harvesting. **(12)**

Course Material/Learning Resources
Essential Reading:

1. Das M. M. and Saikia M.D (2013), **Watershed Management,** PHI Learning Pvt. Ltd.
2. Dr. Chandrawati Jee Shagufta, (2010), **Rainwater harvesting,** A P H Publishing Corporation.
3. Athavale R.N. (2003), **Water Harvesting and Sustainable Supply in India**. Center of Env. Ed.

Suggested Reading:

1. Prabhakar Singh (2022), **Rain Water Harvesting & Conservation Manual**, A Puri Publication.
2. Singh D.K. (2012), **Rain water Harvesting**, Oxford Book Company.

COs (2 WTM 3): Soil and Water Conservation

1. Students would be able to explain the basics concept of soil and its origin.
2. Students would be able to describe soil erosion.
3. Students would be able to understand the of soil erosion.
4. Students would be able to understand the concept of water conservation.
5. Students would be able to explain methods of soil and water conservation.

Unit	**Content**
Unit I	Soil: Introduction, formation, composition, classification and importance of soil, physical properties of soil, texture and structure of soil, poorly aerated soil and compact soil, soil reaction. Soil salinity: Alkaline, acidic and sulphide soil, soil fertility. Study of soil and relationship of rock type and geomorphology to various types of soil, soil mapping. **(12)**
Unit II	Soil erosion: Definition, classification nature and extent of soil erosion in India. Mechanics of soil erosion by water and glaciers, factor and process of soil erosion, its impact of environment and biosphere. Universal soil loss equation: Defining all parameters and its use. Forest fire and soil erosion. **(12)**
Unit III	Soil, resource planning and control of soil erosion: Methods of reducing wind velocity and methods of reducing soil erosion by water, soil conservation measures, soil management, causes of soil erosion. Recent development in soil and water conservation. **(12)**
Unit IV	Water conservation: Introduction, benefits, elementary knowledge regarding conservation/saving of water in daily use, in agriculture, in industries. Water loss from the soil, impact of human activity on the water cycle, water quality and its impact on human being, water consumption in India. **(12)**
Unit V	Soil and water conservation practices: Conservation measures, gully control, terracing, building check dams, rock fill dams, reclamation of soil, afforestation. Water harvesting, rainwater harvesting, roof water harvesting. Artificial recharge of ground water: Artificial recharge methods including aquifer storage recovery. Management of artificial recharge aquifers. **(12)**

Course Material/Learning Resources

Essential Reading:

1. Athavale R.N. (2003), **Water Harvesting and Sustainable Supply in India**. Center of Env. Ed.
2. Dr. Suresh R. (2006), **Soil and water conservation engineering**, Standard Publishers Distributors, Delhi-6, Reprint Edition.
3. Gupta S.K. (2019), **Fundamentals of soil and water conservation engineering**

Suggested Reading:

1. Bimal Chandra Mal (2011), **Introduction to soil and water conservation engineering**, Kalyani Publications.

COs (2 WTM 4): Watershed Development and Management

1. Students would be able to explain the basic concept of watershed development.
2. Students would be able to understand the planning and management of watershed.
3. Students would be able to understand the funding in watershed development and project implementation.
4. Students would be able to understand the monitoring in the watershed management.
5. Students would be able to familiar with participatory watershed management.

Unit	**Content**
Unit I	Watershed development: Problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Watershed management: Concept, factors affecting, integrated watershed management. **(12)**
Unit II	Planning: Introduction, scope, objectives and benefits of watershed management, developing steps of watershed planning. Project formulation: Introduction, description of problem, type of project, analysis of project elements, content of project proposal, technical plan, size of the project, project concerns, need assessment, resource inventory, socio-economic survey, participatory rural appraisal. **(12)**
Unit III	Funding: Introduction, source and objectives, release of fund and its arrangement, management of watershed development fund and micro finance. Project implementation: Project team, project management plan, entry program, project implementation approach and project management committee. Capacity Building: Introduction, objective and strategy for capacity building. **(12)**
Unit IV	Monitoring: Definition, purpose and tool of monitoring, effective monitoring, scheduled and unscheduled monitoring, monitor land use changes in conjunction with water quality. Evaluation: Introduction and scope of watershed management evaluation, qualitative and quantitative evaluation, indicators and stages, impact of evaluation. **(12)**
Unit V	Participatory watershed management: Need of people's participation in watershed management, role of watershed associations, user groups and self-help groups, NGO's, case studies in people's participation in watershed management. **(12)**

Course Material/Learning Resources

Essential Reading:

1. Rajvir Singh (2000), **Watershed Planning and Management**, Yash Publishing House, Bikaner.
2. Singh P. K. (2000), **Watershed Management: Design and Practice**, E-media Publications, Udaipur.

Suggested Reading:

1. S. K. Datta (1985), **Soil Conservation and Land Management.** International Book Distributors, Dehradun.
2. Dr. Suresh R. (2006), **Soil and water conservation engineering**, Standard Publishers Distributors, Delhi-6, Reprint Edition.

Activities:
1. Assignment/ Seminar
2.Class test
3. Field work
4. Educational tour to visit the various developed watershed, organizations.
5. Unnat Bharat Abhiyan/ Community Based Participatory Research (CBPR).

Weblink to Equivalent MOOC on SWAYAM

https://onlinecourses.swayam2.ac.in/cec22_ge07/preview

https://onlinecourses.nptel.ac.in/noc22_ag01/preview

PRACTICALS

Syllabus Prescribed for One Year (2023-24) PG Diploma Programme

Programme: PGDWTM (Post Graduate Diploma in Watershed Technology and Management)

Semester II

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands-on/Activity)	(No. of Periods/Week)
2 WTM 5	**LAB-3 (Watershed Hydrology and Soil and water conservation)**	**06**
2 WTM 6	**LAB-4 (Project report)**	**06**

COs (2 WTM 5 - Watershed Hydrology and Soil and water conservation)

Students would be able to:

1. Calculate the morphometric parameters and interpret the drainage basin.
2. Solve the problems on hydrological cycle.
3. Understand hydrological properties of aquifer and ground water flow.
4. Analyse the ground water quality for different purposes.
5. Execute the watershed programme through water resource management.

List of Practical/Laboratory Experiments/Activities etc.

1. Morphometric analysis.

2. Practical exercise on hydrological cycle.
3. Hydrological properties and ground water flow.
4. Groundwater quality.
5. Groundwater management.

Reference Books:

1. Das M. M. and Saikia M.D (2013), **Watershed Management,** PHI Learning Pvt. Ltd.
2. Nandipati Subba Rao (2016), **Hydrogeology Problem with Solution,** PHI learning private limited.

COs (2 WTM 6- Project report)

1. The project provides an opportunity to students to demonstrate their abilities to carry out independent field research.
2. Students would be able to think and work in an original way, contribute to subject knowledge and overcome genuine problems in watershed management.

Project report:

Students will have to select the project topic and watershed area in consultation with the teachers/Head, Department of Geology. The student has to submit the two copies of project report under taken by him before practical examination of Semester II. Student has to appear for the presentation and viva-voice on project report.