Course Code	Course Title	L	T	P	C
BCLE216L	Water Resource Management	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The objectives of this course is to :

1. Acquire the basic principles of water resources and its planning and management.
2. Enhance the knowledge on recent technologies in assessing the water resources.
3. Identify the challenges facing water management in varied climate types around the world.

Course Outcomes

Upon completion of this course, the student will be able to :

1. Understand the planning of water resources and need for water resource management.
2. Understand the water resource potential in global, India scenario and explore the water resources using different technologies.
3. Acquire a knowledge international and national water law and its policy.
4. Explain the concept of water in agricultural and economic aspects.
5. Predict the future trends of water demand and its management during crisis.

Module:1	Water, A Multi-Dimensional Resource	5 hours

Water resources planning-Multi-dimensional management-Water withdrawal and consumption by sector-Stress, international policy-Climate change, oceans, challenges and need for water resource management.

Module:2	Global and Indian Scenario for Water Resources	4 hours

Surface Water and Groundwater Global and Indian Scenario-Quality of water resources-Water use and sustainable reuse methods-Usable water resources by continent and country-Water footprint.

Module:3	Water Resources Assessment	5 hours

Network design-Stream flow gauging-Weir design-Gauges-Current gauging-Salt dilution-Geophysical exploration-Test drilling-Application of remote sensing techniques.

Module:4	Water in Agricultural Systems	7 hours

Water for food production, virtual water trade for achieving global water security, irrigation efficiencies, irrigation methods and current water pricing, water for livestock and processing, water pollution from agricultural production

Module:5	Water Economics	8 hours

Economic characteristics of water good and services-Nonmarket monetary valuation methods-Water economic instruments-Policy options for water conservation and sustainable use, pricing, distinction between values and charges-Private sector involvement in water resources management.

Module:6	Water Legal and Regulatory Settings	8 hours

National and International Framework for Water Law; Basic structure of water law- An overview of water law in India -Evolution of water law, key features of water law, evolving water law and policy-Water policy for Irrigation, decentralization and participation in irrigation management, and the policy measures proposed to establish water user associations. National level initiatives for regulation of groundwater, State groundwater laws and rainwater harvesting.

Module:7	**Demand Management**	**6 hours**
Balancing supply and demand-Economic theory of supply and demand-management by use of tariffs-Timing, long-term, operational time-frame-Crisis management-Cost of water-Future trends-Economic value of water-Loss control-Water harvesting.		
Module:8	**Contemporary issues**	**2 hours**
Total Lecture Hours		**45 hours**

Text Book(s)

1. David Stephenson, Water Resources Management, 2004, A. A. Balkema Publishers, Netherlands.

Reference Books

1. Louis Theodore, Ryan Dupont R., Water Resource Management Issues, Basic Principles and Applications, 2020, CRC Press, Taylor & Francis Group, New York.
2. Philippe Cullet and Sujith Koonan, Water Law in India- An Introduction to Legal Instruments, 2017. Second Edition, Oxford University Press, New Delhi.
3. Subramanya. K., Engineering Hydrology, 2020, Fifth Edition, McGraw Hill Education Pvt. Ltd., New Delhi.

Mode of Evaluation: CAT, Assignment, Quiz, FAT.

Recommended by Board of Studies	24.02.2022		
Approved by Academic Council	No. 66	**Date**	16-06-2022

BAG2009	Soil and Water Conservation Engineering	L	T	P	J	C
		1	0	2	0	2
Pre-requisite	BAG1020	1.0				

Course Objectives: The course is aimed at

1. Providing knowledge on different surveying methods used in agricultural field
2. Imparting knowledge on the loss of soil and techniques to conserve soil
3. Describing techniques of water harvesting and watershed concepts

Expected Course Outcome: At the end of the course the student should be able to

1. Apply different surveying methods to measure area in agricultural field
2. Determine soil loss for a specific area based on erosivity and erodibility factor
3. Relate different techniques to control wind erosion
4. Apply rain water harvesting methods to conserve water
5. Interpret case studies related to soil and water conservation
6. Design irrigation systems and plan erosion control measures

Student Learning Outcomes (SLO):	1,5, 17

Module:1	Surveying, soil and water erosion	5 hours	

Surveying and leveling: chain, compass, plane table survey, land measurement and computation of area. Simpson's rule and Trapezoidal rule. Soil erosion: causes,effects of soil erosion, geologic and accelerated erosion. Universal soil loss equation. Soil loss measurement techniques. Water erosion: causes,forms, erosivity and erodibility.Mechanics of water erosion: splash, sheet, rill and gully erosion.

Module:2	Erosion control and conservation techniques	4 hours	

Biological measures: contour cultivation, strip cropping and cropping systems. Vegetative measures:*XXXetiver* and other natural grass barriers. Mechanical measures: contour bund, graded bund, broad beds and furrows, basin listing, random tie ridging.Mechanical measures for hill slopes: contour trench, bench terrace, contour stone wall and gully control structures.

Module:3	Wind erosion	3 hours	

Factors influencing wind erosion. Mechanics of wind erosion: suspension, saltation and surface creep. Control measures: windbreaks and shelterbelts. Sand dunes and their stabilization.

Module:4	Rain water harvesting	2 hours	

In-situ soil moisture conservation: micro catchments and eroded catchments. Roof water harvesting: storage and its use for domestic and groundwater recharge. Farm ponds and percolation ponds. Watershed concept and watershed management.

Module:5	Contemporary Issues	1 hours	

Lecture by expert

Total Lecture hours:	15

List of Experiments

1.	Study of survey instruments-chains, compass, plane table, dumpy level; chains &cross staff survey-linear measurement, plotting & finding areas.	4 hours
2.	Compass survey: observation of bearings, computation angles, radiation and intersection method	4 hours
3.	Leveling: fly levels, determination of difference in elevation	2 hours

4.	Calculation of erosion index, estimation and measurement of soil loss	4 hours
5.	Contour maps: Area and volume computations	2 hours
6.	Design of grassed water ways and bench terracing system	4 hours
7.	Design of a contour bund and graded bund	2 hours
8.	Water flow measurement, water duty and irrigation efficiency	4 hours
9.	Water requirement, agricultural drainage, sprinkler and drip system lay out	2 hours
10.	Problems on wind erosion	2 hours
	Total Laboratory Hours	**30**

Text Book

1.	Huffman, Rodney L., Delmar D. Fangmeier, William J. Elliot, and Stephen R. Workman. 2013. Soil and Water Conservation Engineering, 7th edition. American Society of Agricultural Engineers. Michigan, USA.
2.	Khan Towhid Osman. 2013. Soil Degradation, Conservation and Remediation. Springer, Germany.

Reference Books

1.	Ghanashyam Das. 2009. Hydrology and Soil Conservation engineering: Including Watershed Management. Prentice Hall India Learning Private Limited, India.
2.	Gurmail Singh et al., 1990. Manual ofsoil and water Conservation practices in India.Oxford & IBH Publishing Co., New Delhi, India.

Mode of Evaluation: Assignments, Quiz, Continuous assessments and Final assessment test

Recommended by Board of Studies	05-03-2018		
Approved by Academic Council	No. 49	**Date**	15.03.2018

CLE2004	WATER RESOURCE ENGINEERING	L	T	P	J	C
		2	0	2	4	4
Pre-requisite	**MEE1004 – Fluid Mechanics**	**Syllabus version**				
		1.0				

Course Objectives:

1. To motivate the students to identify, formulate, solve the complex problem to manage the water resource related issues.
2. To prepare the students to synthesize data and technical concepts to apply in water resources engineering.
3. To develop the ability of the students to conduct appropriate experiments, analyse and interpret data and use engineering judgement to draw conclusions in water resources problems.
4. To get the exposure about the concept of irrigation and flood control.
5. To provide the students an opportunity to work as a part of a project team.
6. To train the students for a successful career in water resources engineers

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the various components of hydrological cycle and the spatial and temporal variation of rainfall.
2. Determine the different methods and hydrological models to estimate the stream flow.
3. Examine the different techniques to calculate the probable maximum flood based on different returned period.
4. Evaluate the basic aquifer parameters and groundwater resources for different hydro-geological boundary conditions.
5. Understand the different methods of irrigation and find the optimum methods of irrigation for judicious use of water resources.
6. Examine different distribution system of irrigation canal and the basic design of lined and unlined irrigation canal.
7. Apply the mathematics, science and technology to design the minor irrigation structures to develop the command area.

Student Learning Outcomes (SLO):	2, 7, 9, 17

Module:1	**Precipitation Measurement and Analysis**	**4 hours**

Hydrologic cycle and budget, Precipitation variability, rainfall and snow measurement techniques, design of precipitation gauging network, Hydrologic Abstractions-Infiltration-evaporation-evapotranspiration-interception and depression storage, rain harvesting-design procedure.

Module:2	**Stream Flow**	**5 hours**

Measurement of stream flow; factors affecting stream flow; hydrograph analysis, base flow separation, unit hydrograph and curve number methods of stream flow determination, synthetic unit hydrograph, hydrological modeling for stream flow estimation, methods for peak discharge estimation.

Module:3	**Flood Analysis**	**3 hours**

Design flood estimation, frequency analysis, flood routing, storm drainage design, flood migration, flood damage analysis.

Module:4	**Ground Water**	**4 hours**

Ground water hydrology, Application of Darcy's law and Aquifer characteristics, Models for

Groundwater flow analysis, steady state well hydraulics – Fundamentals of unsteady state.		
Module:5	**Irrigation Practices**	**5 hours**
Need for Irrigation in India,Scope, National Water Policy, Physical properties of soil that influence soil moisture characteristics – Concept of soil water potential and its components, Crop water requirements-Irrigation Scheduling- Irrigation efficiencies – Duty-Delta-base period, Surface and Subsurface methods of Irrigation, Standards for irrigation water, Water logging and consequences – Salinity and alkalinity-Reclamation		
Module:6	**Canal Irrigation**	**4 hours**
Classification of canals, Alignment of canals, Design of rigid boundary canals, Lacey's and Tractive force concepts in canal design, lining of canals; Sediment transport in canals, River training		
Module:7	**Irrigation Structure**	**3hours**
Design procedure for –Canal Head works-Canal regulators-Canal drop –Cross drainage works-Canal Outlet-Escapes, Lining and maintenance of canals		
Module:8	**Contemporary issues**	**2 hours**
Total Lecture hours		**30 hours**

Text Book (s)	
1.	Subramanya. K., " Engineering Hydrology" McGraw Hill Education (India) Pvt. Ltd. (2013)
2.	Santosh Kumar Garg, "Irrigation Engineering and Hydraulic Structures",Khanna Publishers, New Delhi, (2013)
Reference Books	
1.	Chow, V.T., Maidment, D.R. and Mays, W.L., (2010) "Applied Hydrology", TataMcGraw Hill Education Pvt. Ltd.
2.	Punmia. B. C., Ashok Kumar Jain, Arun Kumar Jain and Pande Brij BasiLal, (2012) "Irrigation and Water Power Engineering", Laxmi Publications (P) Ltd.
3.	Mays, L.W.(2010). Water Resources Engineering, John wiley and sons.
4.	Todd D.K. and Larry W. Mays (2005)"Groundwater Hydrology", John Wiley & Sons, Inc, New York.
5.	A.K. Rastogi, (2011) "Numerical Groundwater Hydrology", Penram International Publishing (India) Pvt. Ltd.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Laboratory exercises	**30 hours**
[1] Models for Groundwater flow analysis [2] Estimate seepage losses and reservoir losses. [3] Seepage analysis using software [4] Reservoir operation losses [5] Flood analysis [6] Rainfall runoff modeling	

Sl. No.	**Project Titles (J component)**	**hrs**
1.	Advanced rain water harvesting structures	**60hrs**
2.	New methods of irrigation	
3.	Groundwater modeling using MODFLOW	
4.	Flood frequency analysis	

5.	Rainfall-runoff model			
Recommended by Board of Studies	09.06.2015			
Approved by Academic Council	37th ACM	**Date**	16.06.2015	