GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-V

Course Title: Water Resource Engineering
(Course Code: 4350602)

Diploma program in which this course is offered	Semester in which offered
Civil Engineering	5th Semester

1. RATIONALE

The quantitative study of the hydrologic cycle, or how water is distributed and circulated among the earth's atmosphere, land, and oceans, is known as water resources engineering. Civil engineers play a vital role in water resource systems' optimal planning, design, and operation. Due to extensive industrial development, population increase, and changing lifestyles, our need for water is rising quickly. As a main supply of water, rain is what we rely on the most. Engineer having the challenge to restore water of unequal and uneven rainfall over rainy seasons so need to river connected structure to storage so resolving the water storage issue by diverting excess water from plains to deficient regions. The groundwater system is another significant source of water, and it likewise heavily depends on prior years' rainfall. We know that the groundwater table is fast dropping due to extensive consumption, overuse, and annual rainfall deficiency. This course is specifically created for Diploma in Civil Engineering students in order to emphasize the concept of water resource engineering while also raising knowledge about the proper use and conservation of water. It has been made an effort to acquire theoretical knowledge with a focus on particular elements of managing water resources. The curriculum especially addresses the themes of hydrology, runoff, interlinking of river, watershed management, groundwater recharge, water harvesting structures, etc.

2. COMPETENCY

The curriculum should be established and course material should be presented with the intention of helping students develop a variety of abilities that will enable them to achieve the following competency:

- **Impart the fundamental skills and knowledge necessary to execute the practice of water resources engineering.**

3. COURSE OUTCOMES (COs)

The theory should be taught and the exercises should be done in a way that allows students to illustrate the course objectives by demonstrating various learning outcomes in the cognitive, psychomotor, and affective domains to demonstrate following courses outcomes.

(1) Explain the importance and principles of Hydrology.
(2) Estimate hydrological parameters and apply concepts of it in the interlinking of rivers.
(3) Articulate the basics of Groundwater flow.
(4) Calculate reservoir capacity and select suitable storage work for given site condition.
(5) Design the appropriate rainwater harvesting scheme and required structures for given

Conditions.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate the integration of COs, and the remaining 20 marks is the average of 2 tests to be taken during the semester for assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the Sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	Draw labelled sketch of:		12*
1	• Hydrological cycle	I	
2	• Rain gauge	I	
3	• Components of gravity dam and earthen dam section.	IV	
4	• Components of Diversion Head works	IV	
5	• Roof-top rainwater harvesting system	V	
6	• Types of Aquifers	II	
7	• Concept of interlinking of river structure and assemble	III	
8	Calculate average rainfall for the given area using the arithmetic mean method & Isohyetal method	I	2*
9	Draw a Thiessen polygon for a given area with rain gauge station points.	I	2*
10	Calculate Runoff for given catchment area using empirical formula	I	2*
11	Compute optimum number of rain gauge for given catchment area	I	2*
12	Calculate reservoir capacity from the given data.	II	2*
13	Estimation of flood using unit hydrograph.	II	2*
14	Prepare presentation on the technical details of any one emerging technique in water resource engineering.	III	2
15	Field Visit	IV	2
	Total		**28**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weight age in %
	For PrOs 1 to 12	
1	Initiative of student in collecting data and computation.	20
2	Ability to work with team/Group	10
3	Comprehension and presentation skill	30
4	Correctness of design calculations and drawing	30
5	Punctuality and Neatness	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment's with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No
1	Technical Drawings, maps	1,2,4,6,7
2	Digital Plan meter	9
3	Drawing instruments	1,2,4,6,7,8,10, 11
4	Computing Devices	8,10,11,12

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned Cos and PrOs. More could be added to fulfil the development of this competency.

a) Demonstrate working as a leader/a team member.
b) Follow safety practices on site.
c) Follow ethical practices.
d) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. **UNDERPINNING THEORY** Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order for the development of the COs and competency

is not missed out by the students and teachers. If required, more such higher-level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – I Introduction and Hydrology	1.a Justify the need of irrigation for the given area 1.b Describe the advantages and ill effects of irrigation in the given situation 1.c Estimate Average Rainfall in the given situation using the given method 1.d Explain the construction and functioning of the given type of rain gauge.	1.1 Introduction to W.R.E., Objectives of Water Resource development, water resources of India 1.2 Utilization of Water resources 1.2.1 Irrigation 1.2.2 Water supply 1.2.3 Hydroelectric power generation 1.3 Types & Methods of Irrigation 1.3.1 Subsurface irrigation 1.3.2 Surface irrigation i Uncontrolled flooding method, ii Border strip method, iii Check method, iv Basin method, v Furrow method, vi Sprinkler irrigation method vii Drip irrigation method 1.4 Advantages & ill Effects if irrigation. 1.5 Hydrology: 1.5.1 Definition & Concept of Hydrological Cycle, forms & Types of Precipitation 1.6 Measurement of Rainfall 1.6.1 Rain Gauge i Non Recording type Rain gauge ii Recording type Rain gauge 1.7 Methods of calculating average rainfall i Arithmetic mean method, ii Isohyetal method, iii Theissen polygon method. 1.8 Determine optimum no. of rain gauges for given catchment area.
Unit – II Runoff and Interlinking of Rivers	2.a Describe Runoff 2.b Compute Runoff using by various empirical formula 2.c Explain Evaporation transpiration, factor affecting on it 2.d Explain Hydrograph, unit	2.1 Runoff 2.1.1 Introduction of runoff 2.1.2 Factor affecting Runoff 2.1.3 Runoff calculating using empirical formula only 2.2 Evaporation, Transpiration & Evapotranspiration 2.2.1 Factor affecting Evaporation

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	hydrograph and uses in Engineering. 2.e Discuss the interlinking of rivers and NRL projects in India. 2.f Identify various interlinking Projects in India, Needs, Plan. 2.g Describe Classification of rivers, Flood in river, fore casting methods, flood Control in India.	2.3 Hydrograph 2.3.1 Unit hydrograph 2.3.2 Uses 2.4 Introduction of interlinking of rivers 2.4.1 National River linking project [NRLP] 2.4.2 Benefits of National River linking project 2.4.3 Interlinking of rivers in India: Need, objective and plan 2.4.4 Technical features of Saurashtra Narmada Avtran Irrigation Yojana [SAUNI YOJNA] 2.5 Classification of rivers 2.5.1 Major rivers in India and Gujarat 2.5.2 Interlinking of rivers in India and its importance 2.6 Flood, flood forecasting 2.7 Flood control in India 2.7.1 River training works 2.7.2 Object of river training 2.7.3 Classification of river training 2.7.4 Methods of river training 2.7.5 Levees 2.7.6 Guide banks 2.7.7 Spurs 2.7.8 Types 2.7.9 Artificial cut offs 2.7.10 Launching apron 2.7.11 Pitching of bank 2.7.12 Pitched Island 2.7.13 Miscellaneous methods
Unit– III Groundwater and its Management	3.a Define ground water and identify ground water sources 3.b Explain the terms related to ground water 3.c List the types of wells and describe characteristics of each type of well 3.d Illustrate necessity of ground water recharging 3.e Compare various methods of Recharging ground water. 3.f Explain phenomenon of Sea water intrusion	3.1 Sources of ground water 3.2 Importance of ground water and Comparison of ground water source with other sources of water on dependability 3.3 Terms related to groundwater engineering: 3.3.1 Aquifer, Aquiclude, Aquifuge, Aquitard, porosity, Specific yield, Specific retention, storage coefficient, coefficient of permeability, coefficient of transmissibility, Yield, specific yield 3.4 Types of well Open, Tube and flowing

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
		well concept, location and importance 3.5 Necessity of recharging 3.6 Types of artificial recharge i Spreading method. ii Pit method / khet-talavadi iii Induced recharge method iv Recharge well method. v Sub-surface dam. vi Check dam series vii Ponds viii Unlined canals 3.7 Sea Water Intrusion phenomenon 3.8 Relationship between Salt water/Fresh water interface 3.9 Disadvantages and Remedial measures to counteract salt water intrusion
Unit– IV Storage and Distribution Works	4.a Explain Various Surveys/Investigation carried out In Storage works 4.b Discuss reservoir capacity And its Losses 4.c Explain the Storage zones of The reservoir 4.d Give Classification and types Of dams 4.e Describe the purposes & Components of Diversion Head works 4.f Explain about weir and Barrage 4.g Give a Classification of the Canal based on function &Canal lining	4.1 Surveys/Investigation for; 4.1.1 Hydrological data 4.1.2 Geological data 4.1.3 Topographical investigation 4.1.4 Legal data 4.1.5 Water Rights Policy 4.1.6 Economic data 4.1.7 Benefit-cost ratio 4.2 Site Selection for Reservoir & Storage zones 4.3 Methods of estimating reservoir Capacity 4.4 Losses in Reservoir 4.5 Classification of Dams & their Types 4.5.1 Gravity dam 4.5.2 Earthen dam 4.5.3 Arch dam 4.5.4 Buttress dam 4.5.5 Rock fill dam 4.6 Factors affecting the selection of the type of dams and selection criteria for the site of the dam 4.7 Components of Gravity Dam and Earthen dam 4.8 Purpose and Components of Diversion head works 4.9 Explain the difference between the

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
		Weir and Barrage and their types 4.10 Classification of canal based on Function 4.11 Canal Lining, Advantages , Materials and methods used
Unit – V Watershed Management & water Harvesting & Water Reuse	5.a Describe important characteristics of "water shed" 5.b Explain necessity of soil erosion 5.c Describe Rain water harvesting & methods. 5.d Evolve strategies of enhancing people's participation in Watershed management. 5.e Discuss water harvesting & water reuse	5.1 Concept of "water shed" 5.2 Classification of water sheds **5.3 Characteristics of water shed, size, shape** 5.4 Soil & Water conservation 5.5 Necessity of Soil erosion 5.5.1 Causes 5.5.2 Effects 5.5.3 Remedial measures against erosion 5.6 Necessity of rain water harvesting 5.6.1 Importance of Rain water harvesting 5.7 Roof-top rain water harvesting method and its design 5.8 Watershed management & people's participation. 5.9 Role of cooperative society in watershed management 5.10 Water harvesting 5.11 Runoff collection 5.12 Onsite detention basin 5.13 Seepage control 5.14 Method evaporation control 5.15 Water reuse 5.16 Types of reuse technology 5.17 Water reuse methods 5.18 Benefits of recycled water
Unit– VI GIS Application &software used in water Resources Engineering	6.a Understanding the Basic Concept of GIS 6.b Illustrate the Uses of GIS in Water resource engineering 6.c Describe the Software Used for GIS application in Water resource	6.1 Fundamentals of Geographical Information system and Geospatial data 6.2 List out uses of GIS in water resource Engineering and give its brief. 6.2.1 Use in the Management of Geospatial data 6.2.2 Flood and Drought Risk Assessment 6.2.3 Mapping of water resources 6.2.4 Groundwater management 6.2.5 Quality analysis of water 6.2.6 Water supply management 6.3 List out software used for GIS application in the water resource field and its Primary function

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
		6.3.1 Esri ArcGIS/QGIS 6.3.2 HEC RAS

***Note**:TheUOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Introduction and Hydrology	6	3	3	4	10
II	Runoff and interlinking of rivers	10	4	6	6	16
III	Groundwater and Its management	6	2	2	6	10
IV	Storage and Distribution works	10	2	4	10	16
V	Watershed management & water harvesting and water re-use	8	2	4	8	14
VI	GIS application & software used in water resource engineering	2	2	2	--	4
Total		**42**	**15**	**21**	**34**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
***Note**: This specification table provides general guidelines to assist students in their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U, and A) in the question paper may vary slightly from the above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, the following are the suggested student-related ***co-curricular*** activities that can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct the following activities in groups and prepare reports of about 5 pages for each activity, also collect/record physical evidence for their (student's) portfolio which will be useful for their placement interviews:

a) Collect data and drawings from various departments.
b) Assimilate data to be used in the required form
c) Undertake micro project
d) Interpret data
e) Prepare drawings and calculations
f) Prepare presentations
g) Case study of Technical features of Saurashtra Narmada Avtran Irrigation Yojana [SAUNI YOJNA]
h) Visit the nearby Dam, Canal network, SUNI YOJNA, water shed structure like ket-talavdi , Rain water harvesting structure.

i) Conducted awareness program on Water Harvesting , Ground Water Recharge , Sea water Intrusion

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub M topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.11***, teachers need to ensure the creation of opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environmental and sustainability
g) Expert lecture by water resource engineer about the emerging scenario of this field or industry experts

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should preferably be ***individually*** undertaken to build up the skill and confidence in every student to become a problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-bawd, or field-based. Each macro-project should encompass two or more Cos which are in fact, integrations of PrOs, UOs and ADOs. Each student will have to maintain a date work diary consisting of individual contributions to the project work and given seminar presentation of it before submission. The total Duration of the micro-project work should not be less than 16 [sixteen] student engagement hours during the course. The student ought to submit a micro-project by the end the semester to develop the industry-oriented Cos.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a list of existing Storage works and diversion works of the district with full details.
b) Prepare a report on existing water harvesting structures in your city.
c) Conduct survey related to any watershed development projects in your state.
d) Prepare presentations on emerging topics or from the theory related to water resources engineering.
e) Identify irrigation methods used in your city/village and prepare a report on it.

f) Prepare a technical summary of all rain gauge stations situated in your district from irrigation department/concerned offices in groups of two/three students.
g) Collect technical details of river interlinking project of your state/country Except SAUNI YOJNA.
h) Prepare list of Perennial/Non perennial river of India on which any dam is situated.
i) Collect information about ground water observation well/recharge well (location, size, diameter, shape, depth, purposes) of your district from ground water board/ concerned offices in group of two/three students and prepare summary of it.
j) Develop the 2D or 3D model of Rail water forecast equipment , dam, canal, watershed structure , River linking project

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year, and ISBN
1	Engineering Hydrology	K. Subramanya	McGraw Hill Education ISBN-10: 1259029972
2	A Textbook of Hydrology and Water Resources Engineering	R K Sharma	Dhanpatrai & Sons, Delhi ISBN: 8121921287
3	Groundwater	H M Raghunath	New Age International Ltd., New Delhi ISBN: 9788122419047
4	Hydrology & Water Resources Engg.	S.K. Garg	Khanna Publications, Delhi ISBN-13. 978-8174090614
5	GIS in water resource engineering	Dr. Gajraj Singh	SBS Publishers Pvt Ltd. ISBN: 9789380090511
6	Interlinking of Indian Rivers	Radhakant bharti	Lotus Press ISBN-13. 978-8183820417
7	Morden water Resources Engineering	Lawrence k. Wang , Chih Ted Yang	Springer Science, ISBN: 978-1-62703-595-8

14. SOFTWARE/LEARNING WEBSITES

(1) https://swhydrology.gujarat.gov.in/

(2) https://guj-nwrws.gujarat.gov.in/

(3) https://sardarsarovardam.org/

(4) https://archive.nptel.ac.in/courses/

(5) Virtual Lab by Ministry of Education, Government of India https://www.vlab.co.in/

(6) https://www.youtube.com/watch?v=fx1uUek3Iqg

(7) https://www.youtube.com/watch?v=vDr1PiNhYz8

(8) https://www.youtube.com/watch?v=2s2b5-EsmV0

15. PO-COMPETENCY-CO MAPPING

Semester IV	Water Resources Engineering (Course Code: 4350602)									
	POs and PSOs									
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning	PSO 1	PSO 2	PSO 3 (If needed)
Competency	• **Impart the fundamental skills and knowledge necessary to comprehend the practice of water resources engineering**									
CO a) Explain the importance and principles of Hydrology	3	--	--	--	2	--	3			
CO b)Estimate hydrological parameters and apply concepts of it in the interlinking of rivers	3	3	3	2	3	3	3			
CO c) Articulate the basics of Groundwater flow	3	3	2	2	2	3	3			
CO d)Calculate reservoir capacity and select suitable storage work for given site condition.	2	3	3	3	3	2	3			
CO e)Design the appropriate rainwater harvesting scheme and required structures for given Conditions.	3	3	3	2	3	3	3			

Legend: '**3**' for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

17. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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