Program Name : **Civil Engineering Program Group**

Program Code : **CE/CR/CS**

Semester : **Fifth**

Course Title : **Water Resource Engineering**

Course Code : **22501**

1. RATIONALE

Water is very important resource for the life of humans and plants and therefore need to be optimally used and conserved. In today's age, there is demand of water and is growing day by day, thus resulting in scarcity of water. Moreover, in India there is uncertain and inequitable rainfall. Therefore, every drop of water is required to be harnessed appropriately using the relevant technological tools and principles. Accordingly, Irrigation structures (dams, canals and allied structures etc), which basically are the backbone structures in the system used to preserve and conserve the water source. In the planning, design, construction, and maintenance of these structures, Civil engineers have a significant role to play. Thus, this course will enable the students to apply and use the basic principles and practices related to irrigation engineering at site. This will help them to implement various schemes like farm ponds, Jalayukt shivar etc. along with conventional irrigation systems.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Design simple irrigation systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Estimate hydrological parameters.
b. Estimate crop water requirements of a command area and capacity of canals.
c. Maintain irrigation structures.
d. Execute the Minor and Micro Irrigation Schemes.
e. Select the relevant Diversion Head works for the specific site conditions.
f. Design, construct and maintain simple Canal structures.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment 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,* ***ESE*** *- End Semester Examination;* ***PA*** *- Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

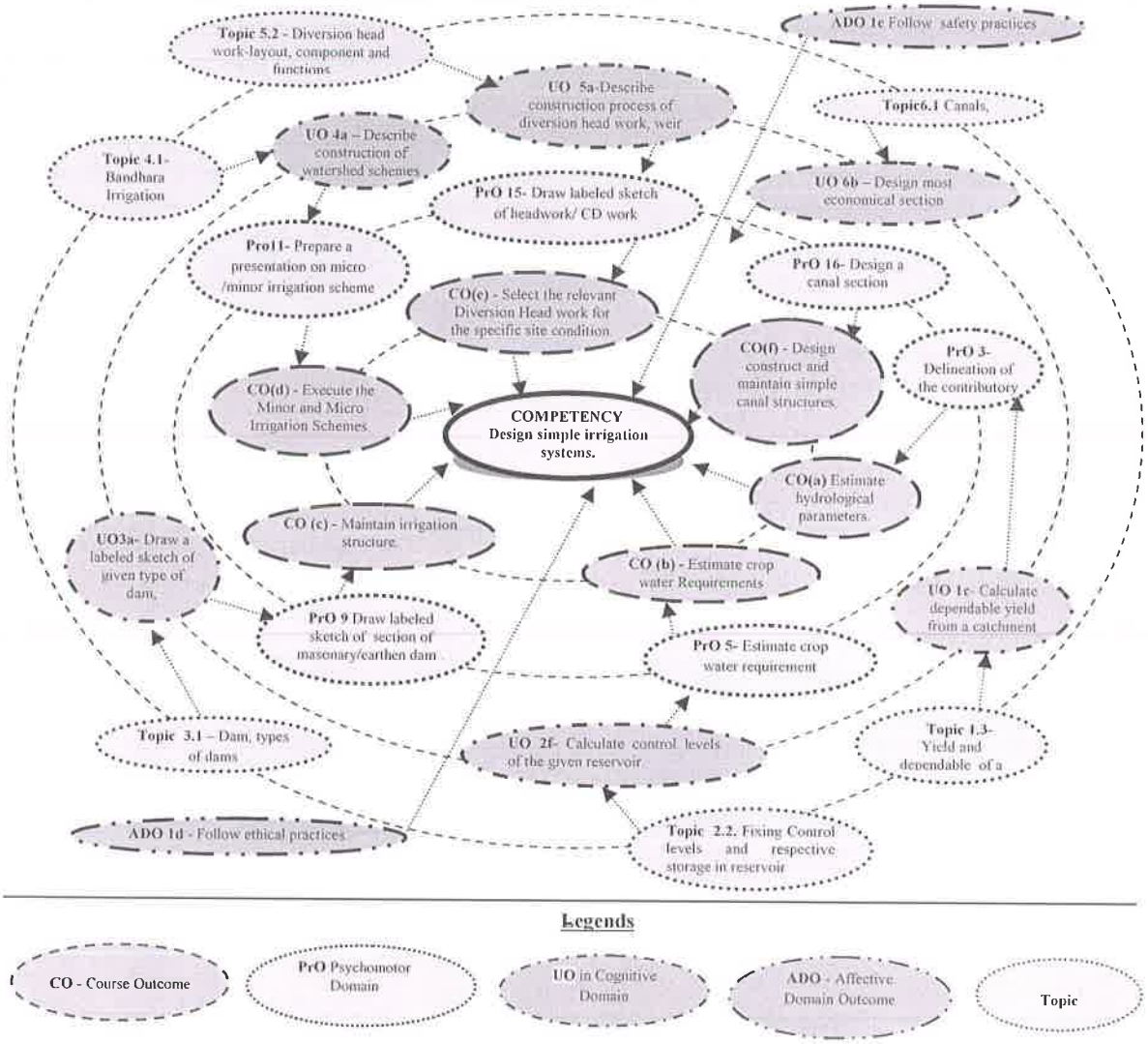

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Calculate average rainfall for the given area using arithmetic mean method .	I	2*
2	Calculate average rainfall for the given area using isohyetal ,Theissen polygon method .	I	2*
3	Delineation of the contributory area for the given outlet from the	I	2*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	given topo-sheet.		
4	Compute the yield of the Catchment area demarcated in Sr.No.2.	I	2*
5	Estimate crop water requirement for the given data.	II	2*
6	Estimate capacity of the canal for the given data.	II	2*
7	Calculate reservoir capacity from the given data.	II	2*
8	Calculate control levels for the given data for the given reservoir.	II	2*
9	Draw a labeled sketch of the given masonry/earthen dam section.	III	2
10	Draw the theoretical and practical profile of the given gravity dam section.	III	2
11	Prepare a presentation on the technical details of any one micro or minor irrigation scheme.	IV	2
12	Prepare a model of any irrigation structure using suitable material.	IV	2
13	Prepare a maintenance report for any major/minor irrigation project site in the vicinity of your area, based on field visit.	I,IV	2*
14	Prepare summary of the technical details of any existing water resource project in the vicinity of your area.	III,IV	2*
15	Draw a labeled sketch of the given diversion head works and CD works.	V,VI	2*
16	Design a canal section for the given conditions with estimation of the quantity of material required for lining of the given canal.	VI	2*
	Total		**32**

Note

i. *A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO of the laboratory/workshop/field work is to be assessed according to a suggested sample given below:*

S.No.	Performance Indicators	Weightage in %
1	Initiative of student in collecting data and computation.	20
2	Ability to work with the team/group.	10
3	Comprehension and presentation skill.	30
4	Correctness of design calculations and drawings.	30
5	Punctuality and neatness.	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices on site.
b. Demonstrate working as a leader/a team member.
c. Maintain and preserve reference drawings, maps and equipment.
d. Follow ethical practices.

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The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organising Level' in 2nd year.
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Technical Drawings, maps, topo-sheets	1
2	Digital planimeter.	2
3	Drawings sheet	4
4	Drawing instruments	5
5	Computing devices	6

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction to Irrigation and Hydrology	1a. Estimate average rainfall in the given situation using the given method. 1b. Estimate runoff and flood discharge in the given situation. 1c. Calculate dependable yield from the given catchment for the given data. 1d. Describe ill effects of excess irrigation in the given situation. 1e. Classify the irrigation projects on the basis of given condition. 1f. Justify the need of Irrigation for the given area. 1g. Describe the advantages and ill effects of the Irrigation in the given situation. 1h. Explain the construction and functioning of the given type of rain gauge. Compute the Maximum Flood Discharge using the relevant	1.1. Irrigation and its Classification on the basis of purpose and surface. 1.2. Hydrology : Definition and Hydrological cycle, 1.3. Rain Gauge : Symons rain gauge, automatic rain gauge, 1.4. Methods of calculating average rainfall: Arithmetic mean, Isohyetal, and Theissen polygon method. 1.5. Runoff, Factors affecting Run off, Computation of run –off. 1.6. Maximum Flood Discharge measurement : Rational method and empirical methods. Simple numerical problems. 1.7. Yield and Dependable yield of a catchment, determination of dependable yield.

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	method from the given data.	
Unit – II Water Requirement of Crops and Reservoir Planning	2a. Estimate crop water requirement in the given situation. 2b. Estimate capacity of canal for the given data. 2c. Undertake/conduct survey for the given irrigation project. 2d. Calculate reservoir capacity from the given data. 2e. Suggest relevant measures of silt control in a given situation with justification. 2f. Calculate control levels for the given reservoir from the given data. 2g. Establish the relationship between duty, delta and base period.	2.1 Crop Water requirement : Cropping seasons, Crop period, base period, Duty, Delta, CCA, GCA, intensity of irrigation, factors affecting duty, Problems on water requirement and capacity of canal. 2.2 Methods of application of irrigation water and its assessment. 2.3 Surveys for irrigation project, data collection for irrigation project. 2.4 Area capacity curve. 2.5 Silting of reservoir : Rate of silting, factors affecting silting and control measures. 2.6 Control levels in reservoir. 2.7 Simple numerical problems on Fixing Control levels.
Unit- III Dams And Spillways	3a. Draw a labeled sketch of given type of dam. 3b. Draw theoretical and practical profile of given gravity dam section. 3c. Suggest preventive measures for the given type of dam failure with justification. 3d. Propose the types of spillways and energy dissipaters for the given type of dam with justification. 3e. Suggest the relevant type(s) of gate for the given type of dam(s) with justification. 3f. Suggest suitable measures to maintain the given earthen dam with justification. 3g. Compare the earthen dam with gravity dams with respect to the given criteria such as seepage, foundation, construction and maintenance.	3.1 Dam and its classification: Earthen dams and Gravity dams (masonry and concrete). 3.2 Earthen Dams –Components with function, typical cross section, seepage through embankment and foundation and its control. 3.3 Methods of construction of earthen dam, types of failure of earthen dam and preventive measures. 3.4 Gravity Dams –Forces acting on dam, Theoretical and practical profile, typical cross section, drainage gallery, joints in gravity dam, concept of high dam and low dam. 3.5 Spillways-Definition, function, location and components. 3.6 Emergency and service spillway - ogee spillway and bar type spillway, discharge over spillway. Energy dissipation, Spillway with and without gates. 3.7 Gates- Radial and Vertical.
Unit– IV Minor and Micro Irrigation	4a. Describe the process of construction of watershed scheme of farm pond for the given area.	4.1 Bandhara irrigation : Layout, components, construction and working, solid and open bandhara. 4.2 Percolation Tanks – Need, selection

	4b. Explain the procedure of construction of Bandhara, Percolation tanks and any type of minor and micro irrigation schemes. 4c. Prepare a checklist for maintenance of Bandhara irrigation, Percolation tanks and any type of minor and micro irrigation schemes. 4d. Identify the components of Drip and Sprinkler Irrigation system in the given situation. 4e. Identify the need for drip/sprinkler irrigation scheme for the given area. 4f. Suggest the relevant layout for the specified crop in the given site conditions.	of site. 4.3 Lift irrigation scheme-Components and their functions, lay out. 4.4 Drip and Sprinkler Irrigation- Need, components, Layout, operation and Maintenance. 4.5 Farm ponds, Jalayukt shivar schemes. 4.6 Well irrigation: types of wells, yield of well, advantages and disadvantages of well irrigation.
Unit– V Diversion Head Works	5a. Describe the process of construction of diversion head work, weir and barrage in the given situation. 5b. Prepare a checklist for maintenance of the diversion head work, weir and barrage in the given situation. 5c. Draw a labeled sketch of the given type of diversion head work, weir and barrage.	5.1. Weirs – components parts, types. K.T. weir – components and construction 5.2. Diversion head works – layout, components and their function. 5.3. Barrages – components and their functions. Difference between weir and Barrage.
Unit– VI Canals	6a Estimate the balancing depth of the given canal(s). 6b Design a most economical section for the designed discharge under specified condition for the given type of canal section. 6c Prepare a checklist for the maintenance of the given type of CD work and canal regulator. 6d Estimate the quantity of material for lining of given canal. 6e Prepare a checklist for maintenance of the given canal. 6f Classify the canal on the basis of alignment and position in the given canal network.	6.1. Canals – Classification according to alignment and position in the canal network, Cross section of canal in embankment and cutting, partial embankment and cutting, balancing depth. Design of most economical canal section. 6.2. Canal lining - Purpose, material used and its properties, advantages. 6.3. CD works- Aqueduct, siphon aqueduct, super passage, level crossing. 6.4. Canal regulators- Head regulator, Cross regulator, Escape, Falls and Outlets. 6.5. Canal maintenance.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

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9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Irrigation and Hydrology	12	4	4	6	14
II	Water Requirement of Crops and Reservoir Planning:	12	2	8	6	16
III	Dams And Spillways	14	4	4	4	12
IV	Minor and Micro Irrigation	08	-	4	6	10
V	Diversion Head Works	08	4	4	-	08
VI	Canals	10	-	4	6	10
Total		**64**	**14**	**28**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports for each activity, also collect/record physical evidences 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 required form.
c. Interpret data.
d. Prepare drawings and design calculations.
e. Draw inference from designs.
f. Prepare presentations.

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 topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate thoroughly the relevant experiment to the students before they start doing the practice.

g. Encourage students to refer different websites to have deep in-depth knowledge of the subject.
h. Continuous observation and monitoring of the performance of students in the Laboratory.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become 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-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare a report of cropping pattern, for the given minor or major irrigation project in your area with reference to growth in yield, increase in command and culturable area and economic status of the concern people.
b. Conduct online/internet survey for Water shed management project (s) in the Maharashtra State with a detailed report of all relevant technical inputs.
c. Prepare a report on the executed system of rain water harvesting with reference to its necessity, broad design parameters, economics in your area along with your comments.
d. Summarize the relevant information in the form of the report from internet regarding types of satellite imagery to capture the necessary details of the given water resource projects.
e. Prepare a report on the on any one executed system of Farm ponds/Jalayukt shivar schemes/drip irrigation scheme with emphasis on its suitability, costing, utility and maintenance after undertaking the visit to it.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Irrigation and water power Engineering	Punmia, B.C., Pande, B, Lal	Lakshmi Publications, New Delhi - 110 002. Edition2016 ISBN 13: 9788131807637
2	Irrigation Engineering	Sharma, R.K. and Sharma, T.K.	S.Chand and Company Ltd.Delhi ISBN 13: 9788121921282 Ed.2002
3	Irrigation Engineering	Basak, N.N.	McGraw Hill Education India Pvt. Ltd. New Delhi.Edition1999 ISBN 13: 9780074635384
4	Irrigation and water resource Engineering	Asawa, G.L.	New Age International(P) Limited Publishers. January, 2005 ISBN (13) : 978-81-224-1673-2

S. No.	Title of Book	Author	Publication
5	Irrigation Engineering	Dahigaonkar, J.G.	Asian Book Pvt. Ltd., New Delhi ISBN 13: 9788184120080
6	Irrigation and Hydraulic structures	S.K.Garg	Khanna Publishers, Delhi. ISBN: 978-81-7409-047-9
7	Irrigation Engineering	Priyani V.B.	Charotar Book Stall, Anand.

IS, BIS and International Codes:

1. IS: 4410-Part-V-1982-Canals
2. IS: 4410-Part-VI-1983-Reservoirs.
   Part- VII-1968-Dams.
   Part-XVII-1977-Water Requirement of Crops
3. IS: 5477-Part-II, III and IV -1969-71-Storage zones of reservoirs.

14. SOFTWARE/LEARNING WEBSITES/LEARNING RESOURCES

a. http://nptel.ac.in/courses/105105110/
b. https://wrd.maharashtra.gov.in
c. http://www.imd.gov.in
d. http://www.mahahp.gov.in
e. http://bhuvan.nrsc.gov.in/bhuvan_links.php
f. Charts/Models/Drawings

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