


Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

	Course Title: WATER RESOURCES ENGINEERING		
	Credits (L:T:P) : 4:0:0	Total Contact Hours: 52	Course Code: 15CE52T
	Type of Course: Lectures, Self Study & Student activities	Credit :04	Core/ Elective: Core
CIE- 25 Marks		SEE- 100 Marks	

Prerequisites: Basic knowledge of Hydraulics, Water supply Engineering.

Course Objectives:

1. To apply knowledge of Hydraulics in understanding the principles and problems in the area of water resource engineering.
2. Understand the importance of water conservation and water management for sustainable development.
3. Understand the various systems and methods of irrigation for economic development of the society.
4. To apply the technical knowledge in understanding the functions of various Hydraulic structures.

On successful completion of this course, the student will be able to

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Illustrate the objectives and quantification of water resources development.	R/U	1,2	03
CO2	Explain the importance and principles of hydrology	R/U/A	1,2,3,6,7,10	08
CO3	Inference the various systems and methods of irrigation for economic development of the society.	R/U	1,2,5,6,7,10	10
CO4	Examine the site selection and structural details of water retaining structures.	R/U/A	1,2,5,6,7,10	10
C05	Summarize the details and working principles of distribution, cross drainage and diversion works.	R/U	1,2,5,6,7,10	14
C06	Elaborate the protection of ground water and water resources management	R/U	1,4,5,6,7,10	07
C07	Engage as lifelong learners and possess knowledge for sustainable engineering solutions in global, economical and environmental issues	U/A	1 to 10	*
		Total sessions		52

Legend- R; Remember U: Understand Ap: Application Ay: Analysis C:CreationE:Evaluation

***Related to Student activity beyond classroom hours.**



Programme outcome Attainment Matrix

Mapping of COs with POs	PROGRAMME OUTCOME									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	Basic Knowledge	Discipline Knowledge	Experiments & practice	Engineering Tools	Engineer and society	Environment & Sustainability	Ethics	Individual and Team work	Communication	Lifelong learning
WATER RESOURCES ENGINEERING	3	3	1	1	3	3	3	-	-	3

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If $\geq 40\%$ of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If $< 5\%$ of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

DETAILED COURSE CONTENT

UNIT	COURSE CONTENT	HOURS
1	INTRODUCTION TO WATER RESOURCES ENGINEERING Introduction and objects of water resource development, world water resources, water resources of India and Karnataka, Necessity of irrigation in India, Advantages & Disadvantages of Irrigation	03
2	HYDROLOGY Introduction and importance of hydrology Hydrologic cycle, Precipitation, forms of precipitation, types of precipitation, Rainfall in India, Measurement of rainfall, types of rain gauges (Simon's rain gauge and floating type rain gauge). Mean annual rainfall and methods of computation of average rainfall, (simple problems). Definition of Hydrograph. Definitions of Abstractions from precipitation (Evaporation, Transpiration, Evapotranspiration, Interception, Depression storage, Infiltration), Run-off and Estimation of runoff (Runoff co-efficient & Empirical formula methods-only theory), Factors affecting run-off.	08
3	METHODS OF IRRIGATION AND WATER REQUIREMENT OF CROPS: Methods of irrigation, Subsurface irrigation, Surface irrigation (Border strip method, Furrow method, Basin method), Sprinkler irrigation, Drip irrigation, Advantages and disadvantages of Drip Irrigation & Sprinkler irrigation. Quality of water for Irrigation, water requirements of crops, Base period, duty, delta and their relationship (simple problems). Definitions of Gross command area, cultivable command area, intensity of irrigation, Annual irrigation intensity, Net and gross Sown area, Net & gross irrigated area, Time factor, Capacity factor, Full supply co-efficient. Factors affecting duty, methods of improving duty. Crop seasons – Rabi and Kharif, Irrigation water efficiency. Soil moisture irrigation relationship, Definitions of field capacity, soil moisture	10



UNIT	COURSE CONTENT	HOURS
	content, permanent wilting point, available moisture, soil moisture deficiency. Optimum moisture content, Root zone depth.	
4	RESERVOIRS AND DAMS: Introduction, site selection for reservoirs and dams, Earthen dams, Typical cross section of different types of earthen dam, causes of failures of earthen dams (structural failures). Gravity dams, Elementary profile of a gravity dam, list various forces acting on gravity dam, modes of failure of gravity dams, Inspection galleries. Spillways and its types (Straight drop, Ogee spillway, Chute Spill way, volute type Syphon spillway). Reservoir sedimentation	10
5	DISTRIBUTION WORKS: Canal and its classification (based on alignment, function), Layout of canal system, Canal lining and Maintenance of canals. CROSS DRAINAGE WORKS: Types of cross drainage works, Aqueduct, Canal siphon, Super passage, Level crossing, Inlet and outlet. DIVERSION HEAD WORKS: Definition, Location, layout and components of diversion head works, Sketches and description of Weirs, barrage, Body wall of a weir, divide wall Approach channel, canal head regulator, and Fish ladder Difference between weir and barrage.	14
6	GROUND WATER ENGINEERING: Ground water and its importance, Aquifer, Aquiclude, Aquitard, Aquifuge Aquifer properties -porosity, ground water yield, specific yield, specific retention, permeability, transmissibility. Artificial recharge of ground water and its methods , Ground water pollution protection of wells, Legislation provisions for ground water protection WATER RESOURCE MANAGEMENT: Watershed management and its importance, National water policy, Inter basin water transfer. Definition and application of Cloud seeding.	07

Course Delivery: The course will be delivered through lectures and Power point presentations/ Video

SUGGESTED LIST OF STUDENT ACTIVITIES

1. Visit to nearby Irrigation projects (Existing or on-going)& prepare a detailed report.
2. Visit to nearby meteorological station & collect the meteorological data for past 5 years & prepare a report.
3. Calculate the average rainfall for mini water shed by collecting the meteorological data.
4. Visit to nearby lakes or irrigation tanks& study its present status, suggest restoration measures & prepare a report.
5. Seminars on following topics
 i)Cloud seeding ii) Water shed management iii) Rain water harvesting iv) Restoration of lakes & Reservoirs v) Remote sensing & GIS applications in water resources engineering vi) Urban flood management.
6. Visit nearby agricultural field where micro irrigation techniques are implemented & prepare a report.

NOTE:



1. Students should select any one of the above or other topics relevant to the subject approved by the concerned faculty, individually or in a group of 3 to 5. Students should mandatorily submit a written report and make a presentation on the topic. The task should not be repeated among students. Report will be evaluated by the faculty as per rubrics. Weightage for 5 marks Internal Assessment shall be as follows: (Unsatisfactory **1**, Developing **2**, Satisfactory **3**, Good**4**, Exemplary**5**)

1. Reports should be made available along with bluebooks to IA verification officer

Example of model of rubrics / criteria for assessing student activity

Dimension	Students score (Group of five students)				
	STUDENT 1	STUDENT 2	STUDENT 3	STUDENT 4	STUDENT 5
Rubric Scale	Unsatisfactory 1 , Developing 2 , Satisfactory 3 , Good 4 , Exemplary 5				
1.Literature	1				
2.Fulfill team's roles & duties	4				
3.Conclusion	3				
4.Conversions	5				
Total	13				
Average=(Total /4)	3.25				
Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks One activity to attain last CO (course outcome) may be given to a group of FIVE students					

Note: Dimension should be chosen related to activity and evaluated by the course faculty

Dimension	Rubric Scale				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary
1.Literature	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed
2.Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles
3.Communication	Poor	Less Effective	Partially effective	Effective	Most Effective
4.Conversions	Frequent Error	More Error	Some Error	Occasional Error	No Error



COURSE CONTENT AND BLUE PRINT OF MARKS FOR SEE

Unit	Major Topics	Hours Allotted	Questions to be set for SEE			Marks weightage	weightage (%)	A*	B*
			Cognitive Levels						
			R	U	Ap				
1	INTRODUCTION TO WATER RESOURCES ENGINEERING	02	40%	60%	00%	05	3.5	1	0
			2	3	0				
2	HYDROLOGY	08	16%	35%	50%	30	20.7	2	2
			5	15	10				
3	METHODS OF IRRIGATION AND WATER REQUIREMENT OF CROPS	10	0%	25%	75%	30	20.7	2	2
			5	15	10				
4	RESERVOIRS AND DAMS	10	0%	100%	0%	30	20.7	2	2
			5	25	0				
5	DISTRIBUTION WORKS CROSS DRAINAGE WORKS, DIVERSION WORKS	14	0%	50%	50%	35	24	1	3
			0	17	18				
6	GROUND WATER ENGINEERING: WATER RESOURCE MANAGEMENT:	08	0%	50%	50%	15	10.4	1	1
			0	7	8				
Total		52	11.7	56.5	31.8	145	100	9	10
			17	82	46				

Legend: R; Remember, U: Understand A: Application Ay: Analysis C: Creation E: Evaluation

A*-SEE QUESTIONS TO BE SET FOR (05 MARKS) in PART – A

B*- SEE QUESTIONS TO BE SET FOR (10MARKS) in PART – B

Questions for CIE and SEE will be designed to evaluate the various educational components such as:

Sl. No	Bloom's taxonomy	% in Weightage
1	Remembering and Understanding	68.2
2	Applying the knowledge acquired from the course	31.8
3	Analysis	
4	Synthesis (Creating new knowledge)	
5	Evaluation	

Course Assessment and Evaluation Scheme:

	What		To whom	When/Where (Frequency in the course)		Max Marks	Evidence collected	Course outcomes
	Direct Assessment	CIE	IA	Students	Three IA tests (Average of three tests will be computed)	Test 1	20	Blue books
Test 2						3,4		
Test 3						5,6		
SEE		End Exam	Student activities		05	Report	1,2,3,4,5,6,7	
				End of the course	100	Answer scripts at BTE	1,2,3,4,5,6	
Indirect Assessment	Student Feedback on course		Students	Middle of the course			Feedback forms	1 & 2,3 Delivery of course
	End of Course Survey			End of the course			Questionnaires	1,2,3,4,5,6,&7 Effectiveness of Delivery of instructions & Assessment Methods

*CIE – Continuous Internal Evaluation *SEE – Semester End Examination

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Note to IA verifier: The following documents to be verified by CIE verifier at the end of semester

1. Blue books (20 marks)
2. Student suggested activities report for 5 marks evaluated through appropriate rubrics.
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods

FORMAT OF I A TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks			
Ex: I test/6 th week of sem 10-11 Am	I/II SEM		20			
	Year:					
Name of Course coordinator :			Units: __			
CO's: ____						
Question no	Question		MARKS	CL	CO	PO
1						
2						
3						
4						

Note: Internal choice may be given in each CO at the same cognitive level (CL).



MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks			
Ex: I test/6 th week of sem 10-11 Am	VI SEM	WATER RESOURCES ENGINEERING	20			
	Year: 2017-18	Course code:15CE52T				
Name of Course coordinator CO1,CO2 Answer all questions						
Question	M	CL	CO	PO		
1	List any five advantages of irrigation.	5	R/U	CO1	1,2,4	
2	With a neat diagram explain Hydrologic cycle.	5	R/U	CO2	1,2,4	
3	With a neat diagram explain the working of Floating type of automatic rain gauge.	10	R/U	CO2	1,2,4	
	or Explain the various factors affecting runoff.	10	R/U	CO2	1,2,4	



TEXT BOOKS&REFERENCES

TEXT BOOKS

1. Irrigation and water power engineering-by B.C.Punmia, Pande, B.B.Lal
Lakshmi Publications, 7/21, Ansari Raod, Daryaganj, New Delhi - 110 002.
2. Irrigation and Hydraulic structures S.K.Garg (Khanna Publishers, Delhi)
3. Ground water- H.M.Raghunath, New age international publisher
4. Irrigation Engineering- R.K.Sharma and T.K.Sharma (S.Chand and Company Ltd)
5. Irrigation Engineering-N.N. Basak McGraw Hill Education India Private Ltd New Delhi

REFERENCE BOOKS

1. Principles and practice of irrigation engineering S.K.Sharma(S.Chand and company Pvt. Ltd.
Ramnagar, New Delhi - 110 055
- 2.Irrigation Engineering - voi I, II and III K.R. Sharma
- 3.Theory and design of irrigation structures Varshney, S.C., Gupta AndR.L.Gupta
- 4.A text book of irrigation engineering and Hydraulics structures R.K.Sharma
(Oxford - IBH publishing Co.)
5. Hydrology – Principles, Analysis and design, New age international publisher



MODEL QUESTION PAPER (SEE)

Code: 15CE52T

Diploma in Civil Engineering

III Semester

Course title: **WATER RESOURCES ENGINEERING**

Time: 3 Hours]

[Max Marks: 100]

- Note:** i) Answer any SIX questions from PART - A. Each question carries 05 marks.
ii) Answer any SEVEN Questions from PART - B. Each question carries 10 marks.

PART – A

1. List any five advantages of irrigation.
2. Write a note short note on forms of precipitation.
3. Determine the average rainfall over the catchment area by the Thiessen polygon method. The rainfall recorded at the various rain gauge stations and areas of the Thiessen polygons are tabulated below.

Area of Thiessen polygon (km ²)	Precipitation (cm)
50	3.5
105	4.2
84	5.4
145	4.8
45	4.4

4. Compare Sprinkler irrigation with drip irrigation.
5. Define Base period, Duty, Delta, Permanent wilting point and Field capacity
6. Sketch the elementary profile of gravity Dam.
7. Write a short note on reservoir sedimentation.
8. Explain the difference between Weir and Barrage.
9. Define the following
i) Aquifer ii) Aquifuge iii) Porosity iv) Specific yield v) Permeability

PART – B

10. Explain hydrologic cycle with a neat sketch.
11. Explain the factors affecting run off of a catchment area.
12. Explain various methods of improving Duty.
13. The cultivable command area of a water course is 1200 hectares. Intensity of sugarcane and wheat crops are 20% and 40% respectively. The duties for the crops at the head of the water course are 730 hectares/cumec and 1800 hectares/cumec, respectively. Find the discharge required at the head of the water- course.
14. Draw a neat diagram of typical cross section of a gravity dam.
15. What are spill ways? With a neat diagram explain Chute spillway.
16. With a neat diagram explain classification of canal based on alignment.
17. With a neat diagram explain syphon Aqueduct.
18. Draw a typical layout of Diversion head works and its components.



19. What is artificial recharge of ground water? List various methods and explain any one method.

MODEL QUESTION BANK

CO 1: Understand the objectives and quantification of water resources development.

REMEMBER LEVEL QUESTIONS

1. Write a brief note on world water resources
2. Write a brief note on water resources of India
3. Write a brief note on water resources of Karnataka

UNDERSTANDING LEVEL QUESTIONS

1. What are the advantages of irrigation?
2. What are the disadvantages of irrigation?
3. What are the objectives of water resources development?
4. List the necessity of Irrigation in India

APPLICATION LEVEL QUESTIONS

1. Explain how principles of Hydrology is applied in water resources projects

CO 2: Understand the importance and principles of hydrology

REMEMBER LEVEL QUESTIONS

1. List the various methods of estimating of runoff.
2. Explain various methods of estimating of runoff.
3. What is precipitation and list different forms of precipitation
4. Define the following terms (a) Evaporation, (b) Transpiration, (c) Evapotranspiration, (d) Interception, (e) Depression storage, (f) Infiltration (g) Run-off (h) catchment

UNDERSTANDING LEVEL QUESTIONS

1. With a neat diagram explain Hydrologic cycle.
2. Explain Cyclonic Precipitation.
3. Explain Convective Precipitation.
4. Explain Orographic Precipitation.
5. Mention the difference between convective precipitation and cyclonic precipitation.
6. Mention the difference between convective precipitation and orographic precipitation.
7. Mention the difference between convective precipitation and cyclonic precipitation.
8. Mention the difference between recording and non-recording type of rain gauges.
9. With a neat diagram explain the working of Symon's Rain gauge.
10. With a neat diagram explain the working of Floating type of automatic rain gauge.
11. Explain Runoff co-efficient method for estimation of runoff in a catchment.
12. Explain Empirical formulae method for estimation of runoff in a catchment.
13. Explain the various factors affecting runoff.



APPLICATION LEVEL QUESTIONS

1. The isohyetal map for 24 hour storm gave the areas enclosed between different isohyets, as follows:

Isohyets in mm	38	37	36	35	34	33	32
Enclosed area in Sq.km	72	102	216	310	379	419	488

Determine the average depth of rainfall over the catchment

2. Determine the average rainfall over the catchment area by the Thiessen polygon method. The rainfall recorded at the various rain gauge stations and areas of the Thiessen polygons are tabulated below.

Area of Thiessen polygon (km ²)	Precipitation (cm)
50	3.5
105	4.2
84	5.4
145	4.8
45	4.4

CO 3: Understand the various systems and methods of irrigation for economic development of the society.

REMEMBER LEVEL QUESTIONS

1. Define the following

(a) Gross command area, (b) cultivable command area, (c) intensity of irrigation, (d) Annual irrigation intensity, (e) Net and gross Sown area, (f) Net & gross irrigated area, (g) Time factor, (h) Capacity factor, (i) Full supply co-efficient (j) Duty (k) Delta (l) Base Period

2. Define (a) Field capacity, (b) Soil moisture content, (c) Permanent wilting point, (d) Available moisture, (e) Soil moisture deficiency, (f) Optimum moisture content, (g) Root zone depth.

UNDERSTANDING LEVEL QUESTIONS

1. Mention the difference between surface and subsurface method of irrigation.
2. Explain Border strip method of Irrigation.
3. Explain Furrow method of irrigation.
4. Explain Basin method of Irrigation.
5. Explain Sprinkler method of irrigation.
6. Write short notes on Drip irrigation.
7. What are the advantages and disadvantages of sprinkler irrigation?



8. Mention the advantages and disadvantages of Drip irrigation.
9. What is Irrigation water efficiency
10. What are the factors affecting Duty
11. Mention the various methods of improving Duty

APPLICATION LEVEL QUESTIONS

1. The cultivable command area of a water course is 1200 hectares. Intensity of sugarcane and wheat crops are 20% and 40% respectively. The duties for the crops at the head of the water course are 730 hectares/cumec and 1800 hectares/cumec, respectively. Find the discharge required at the head of the water- course.
2. Determine delta for a crop having base period 140 days and duty 4000 hectares/ cumec.
3. The gross area of an irrigation project is 80,000 ha. Out of this, about 8,000 ha. Have been utilized for construction of dwellings, roads, bridges, etc. The area to be cultivated during rabi is 55,000ha. and during kharif is 48,000 ha. The duty of canal water for rabi crops is 5,000 ha per cumec and for kharif crops is 3,000 ha per cumec. Find the design discharge for the canal after giving 15% allowance for peak discharge and loss of water in transit. What would be the annual intensity of irrigation?
4. Determine reservoir capacity for command area of 60,000 ha, canal losses= 15%, Base period, Duty and intensity of irrigation is as under.

Crop	Base period (Days)	Duty (ha/cumec)	Irrigation Intensity (%)
Sugarcane	360	1700	20
Cotton	180	1500	10
Wheat	120	1800	20
Rice	120	700	15
Vegetables	120	700	15

CO 4: Understand the site selection and structural details of water retaining structures.

UNDERSTANDING LEVEL QUESTIONS

1. Mention the factors to be considered for selection of site for a reservoir.
 2. Draw typical cross section of different types of Earthen dam.
- Draw typical cross section of Gravity dam
 Write short notes on Inspection gallery
 Write short notes on Reservoir sedimentation
 What are spill ways? List different types of spill ways
 With a neat diagram explain Straight drop spill way
 With a neat diagram explain Ogee spillway
 With a neat diagram explain Chute Spill way
 With a neat diagram explain Syphon spillway

APPLICATION LEVEL QUESTIONS

- List the various forces acting on Gravity dam
 List the various modes of failure of gravity dam
 Explain the various causes for structural failures of earthen dam

CO 5: Understand details and working principles of distribution, cross drainage and diversion works.

UNDERSTANDING LEVEL QUESTIONS

1. Explain the classification of canal based on alignment
2. Explain the classification of canal based on function
3. With a neat diagram explain layout of canal system
4. Write short notes on maintenance of canal
5. What are the advantages of canal lining?
6. With a neat diagram explain the working of Aqueduct.
7. With a neat diagram explain the working of Syphon Aqueduct.
8. With a neat diagram explain the working of Canal syphon.
9. With a neat diagram explain the working of Super passage.
12. With a neat diagram explain the working of level crossing.
13. With a neat diagram explain the working Inlet and outlet.
14. Draw a layout showing components of diversion head works.
15. With a neat sketch explain canal head Regulator
16. Mention the difference between weir and barrage
17. With a neat diagram explain the working of Fish ladder

CO 6: Understand protection of ground water and water resources management

UNDERSTANDING LEVEL QUESTIONS

1. Explain the importance of ground water
2. Define the following terms
(a) Aquifer, (b) Aquiclude, (c) Aquitard, (d) Aquifuge
Aquifer properties –(a) porosity, (b) ground water yield, (c) specific yield, (d) specific retention, (e) permeability, (f) transmissibility
3. Explain various methods of artificial recharge of ground water
4. Explain the causes of ground water pollution
5. Write short note on protection of wells.
6. Explain the legislation provisions for ground water protection
7. Explain the various water conservation measures
8. What is water shed management? Explain the importance of watershed management
9. Write short notes on National water policy
10. What is inter basin transfer of water? Explain the advantages and disadvantages of inter basin transfer of water.

