CET306	DESIGN OF HYDRAULIC STRUCTURES	Category	L	T	P	Credit	Year of Introduction
		PCC	4	0	0	4	2019

Preamble: The general objective of this course is to expose the students to the fundamental concepts of hydraulic design of different hydraulic structures and to develop the drawings of minor irrigation structures. This course equip the students to perform the hydraulic design of minor irrigation structures such as cross drainage works, canal falls and regulators and prepare drawings of the same. To impart the knowledge on causes of failure and design criteria of hydraulic structures like dams and canal structures.

Pre-requisite: Fluid Mechanics and Hydraulics, Hydrology & Water Resources Engineering

Course outcome : After the course, the student will able to:

CO1	Elucidate the causes of failure, principles of design of different components of hydraulic structures
CO2	Describe the features of canal structures and perform the design of alluvial canals
CO3	Perform the hydraulic design of minor irrigation structures such as cross drainage works, canal falls, cross regulator
CO4	Prepare the scaled drawings of different minor irrigation structures
CO5	Describe the design principles and features of dams and perform the stability analysis of gravity dams

CO - PO Mapping

1 – Slight (Low), 2 – Moderate (Medium), 3 – Substantial (High)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
DESIGN OF HYDRAULIC STRUCTURES	CO1	3	2					1					
	CO2		2	3									
	CO3	3	3	3									
	CO4										3		
	CO5	3	2				1	1					

Assessment pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	5	5	10
Understand	10	10	20
Apply	20	20	40
Analyze	15	15	30
Evaluate			
Create			

Mark distribution

Total marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
(For the first internal test, minimum two design should be included)		
Assignment/Quiz/Course project	:	15 marks
Assignment should be scaled drawings (in A_2 size sheet)		
Total	**:**	**50 marks**

End semester examination pattern: There will be three parts; Part A, Part B and Part C. Part A contains 2 questions each from Modules I and II, out of which student can answer any one. Total marks for this part will be 30. Each question can have maximum 2 sub-divisions and carry 15 marks. Part B will be for 50 marks with 25 mark for design and 25 mark for drawing (not to scale) based on Module III. In the drawing part, two views should be asked. Part C will be for 20 Marks. Two full questions each from Modules IV and V carrying 10 mark should be asked and the student can answer any one from each module. The examination will be for 3 hours.

Course Code: CET306
Design of Hydraulic Structures
Course Level Assessment Questions

CO1	**Elucidate the causes of failure, principles of design of different components of hydraulic structures**
1	State Khosla's interim conclusions
2	Explain the causes of failure of weirs on permeable soils and state the remedial measures
3	Explain the corrections to be applied on % uplift pressure estimated by the method of independent variables
4.	Obtain the expression for floor thickness as per Bligh's theory

CO2	**Describe the features of canal structures and perform the design of alluvial canals**
1	State the functions of under sluices and divide walls
2	Explain the classification of cross drainage structures
3	Describe the features of a Siphon well drop with a sketch
4.	Explain Kennedy's theory for the design of Alluvial channels
5.	Explain (i) level crossing (ii) canal siphon with sketches
6.	Design an irrigation canal through alluvial soils for the following data : Discharge =20 m^3/sec; Lacey's silt factor =1

CO3	**Perform the hydraulic design of minor irrigation structures such as cross drainage works, canal falls, cross regulator.**
1 (a) (b)	**Design a 1.5 m Sarda Type Fall for a canal carrying a discharge of 40 cumecs with the following data** Bed Level Upstream-105.0m Bed Level Downstream-103.5m Side Slopes of canal-1:1 Full Supply Level Upstream-106.8 m Bank level upstream-107.4 m Bed width-U/s and D/s-30 m Safe Exit Gradient for Khosla's theory-1/5 Sketch following views of the structure: (a) Half plan at top level and half at foundation level (b) Longitudinal sectional elevation
CO4	**Prepare the scaled drawings of different minor irrigation structures**

1. (a)	Design a 1.8 m trapezoidal notch fall for the following data (Assignment): Details above drop: Full supply discharge= 5.5 cumec Bed width= 5 m Bed level= 19.8 Full supply depth=1.6 m Level at the top of the bank=22.4 The bank top width is 1.8 m Details below drop: Full supply discharge= 5.5 cumec Bed width= 5 m Full supply level=19.6 Level at the top of the bank=20.6 The bank top width is 1.8 m
(b)	Develop following drawings to a suitable scale: (a) Half sectional plan at foundation level (b) Section along the centre line of the canal

CO5	**Describe the design principles and features of dams and perform the stability analysis of gravity dams**
1	Explain the features of different types of spillways
2	State the functions of Galleries and Keys in gravity dam
3	Obtain the expression for base width of elementary profile of gravity dams for no tension criteria
4	Differentiate low dams and high dams
5.	Explain the causes of failure of earth dams
6.	Enlist the design criteria of earth dams
7.	State the limitations of thin cylinder theory

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Design of Hydraulic Structures
Syllabus

Module I

Diversion headwork-components and functions; Weirs – types and causes of failure- Impervious floor of hydraulic structures –Bligh's theory, Design of vertical drop weir; Design of impervious floor of hydraulic structures by Khosla's theory

Module II

Canals-types, Cross section of unlined canals and alignment; Design of canals through alluvial soils- Kennedy's theory and Lacey's silt theory. Canal structures- cross drainage structures-types; Canal falls-Necessity, types

Module III

Hydraulic design and drawing of canal structures
(i) Aqueduct; (ii) Siphon Aqueduct; (iii) Canal drop (Trapezoidal Notch Fall); (iv) Sarda type fall (trapezoidal crest- impervious floor design using Khosla's theory); and (v) Cross regulator (impervious floor design using Khosla's theory)

Module IV

Dams-types; Gravity Dams-computation of forces-modes of failure and stability criteria, stability analysis. Elementary and practical profile, limiting height of gravity dams, Galleries, joints, keys, water stops, instrumentation, grouting (brief description only)

Module V

Earth dams-types, causes of failure and design criteria, Arch dams- thin cylinder theory; Spillways-types-Ogee spillway profile; Energy dissipation- stilling basins-Indian standard Type I and Type II (description only)

Text Books:

- Sathyanarayana M. C. Water Resources Engineering-Principles and Practice, New Age International Publishers. 2009
- Garg S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, New Delhi 2006.
- KR Arora. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors, New Delhi. 2010.

References:

- Punmia B.C.Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering. Laxmi Publications (P) Ltd 2009.
- Modi P.N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors, New Delhi 2009.
- Varshney, R.S. Theory & Design of Irrigation Structures -Vol III, Nem Chand & Bros., Roorkee.

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Design of Hydraulic Structures
Course Plan

Module	Topic	Course outcome addressed	No of Hours
Module I (8 Hours)			
1.1	Introduction on different types of Irrigation structures	CO2	1
1.2	Layout of diversion headwork- components and functions	CO2	1
1.3	Causes of failure of weirs on permeable soils and remedies	CO1	1
1.4	Bligh's theory, problem	CO1	1
1.5	Design of vertical drop weir	CO1	1
1.6	Khosla's theory-Interim conclusions and Khosla's first problem	CO1	1
1.7, 1.8	Khosla's method of independent variables- use of charts and corrections	CO1	2
Module II (8 Hours)			
2.1	Types of canals, alignment of canals	CO2	1
2.2	Typical cross sections of unlined canals	CO2	1
2.3	Design of channels through alluvial soils- Kennedy's theory	CO2	1
2.4, 2.5	Lacey's silt theory- problems	CO2	2
2.6	Classification of cross drainage structures	CO2	1
2.7, 2.8	Canal falls – necessity and types	CO1	2
Module III (15 Hours)			
3.1-3.3	Hydraulic design of Aqueduct and demonstration of drawing	CO3, CO4	3
3.4-3.6	Hydraulic design of Siphon Aqueduct and demonstration of drawing	CO3, CO4	3
3.7-3.9	Hydraulic design of Canal drop (Trapezoidal Notch Fall) and demonstration of drawing	CO3, CO4	3

3.10-3.12	Hydraulic design of Sarda Fall with trapezoidal crest and demonstration of drawing	CO3, CO4	3
3.13-3.15	Hydraulic design of Cross regulator and demonstration of drawing	CO3, CO4	3
Module IV (7 Hours)			
4.1	Dams-Types, Computation of Forces acting on dams	CO5	1
4.2	Stability analysis- modes of failure and stability criteria of gravity dams	CO5, CO1	1
4.3	Stresses-No tension criteria, derivation of principal stress	CO5, CO1	1
4.4	Problems on stability analysis of gravity dams	CO5, CO1	1
4.5	Elementary and practical profile of gravity dams	CO5, CO1	1
4.6	Functions and types of galleries, keys and water stops etc in dams	CO5	1
4.7	Instrumentation and grouting of dams	CO5	1
Module V (7 Hours)			
5.1	Arch dams- types, thin cylinder theory	CO5, CO1	1
5.2	Most economical central angle of arch dam, Limitations of thin cylinder theory	CO5, CO1	1
5.3. 5.4	Earth dams, types, causes of failure and design criteria	CO5, CO1	2
5.5	Spillways- Types	CO5	1
5.6	Ogee spillway profile	CO5, CO1	1
5.7	Energy dissipation below spillways-stilling basins	CO5, CO1	1

Model Question Paper

Reg No.:…….. QP CODE: ……..

Name:……

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CET 306
Course Name: DESIGN OF HYDRAULIC STRUCTURES

Max. Marks: 100 Duration: 3 hours

- *Use of Khosla's Chart, Blench Curves and Montague Curves are permitted in the Examination Hall*
- *Assume suitable design data wherever necessary*

PART A

(Answer one full question from each module, each question carries 15 marks)

Module I

1	**a.**	State the functions of under sluices and divide walls.	(6 marks)
	b.	Explain Khosla's corrections.	(9 marks)

OR

2	**a.**	State and explain Bligh's theory.	(5 marks)
	b.	Explain the causes of failure of weirs on permeable soils and state the remedial measures.	(10 marks)

Module II

3	**a.**	Explain the factors to be considered in the alignment of canals.	(5 marks)
	b.	Explain the classification of cross drainage structures.	(10 marks)

OR

4	**a.**	Compare Kennedy's theory and Lacey's theory.	(6 marks)
	b.	Design an irrigation canal through alluvial soils for the following data: Discharge =20 m^3/sec; Lacey's silt factor =1	(9 marks)

PART B
(Answer any ONE full question)

Module III

5 **a.** Design a suitable cross drainage work for the following data: (25 marks)

Canal:

Full supply discharge	= 30 *cumec*
Bed level	= +250.00 *m*
Depth of water	= 1.50 *m*
Bed width	= 20 *m*
Side slope	= 1.5 **H : 1V**
Manning *N* for concrete	= 0.016

Drainage:

High flood discharge	= 250 *cumec*
High flood level	= +247.50 *m*
High flood depth	= 2.50 *m*
General ground level	= +251.00 *m*
Silt factor	= 1.0

b. Develop the following drawings:

i. Half sectional plan at foundation level and at top (15 marks)

ii. Longitudinal section along the centre line of the canal (10 marks)

OR

6 **a.** Design a 2 m trapezoidal notch fall for the following data: (25 marks)

Details above drop:

Full supply discharge	= 5.5 *cumec*
Bed width= 6 *m* Bed level	= 12.000
Full supply depth	=1.5 m
Level at the top of the bank	=14.5

Bank top width is 3 m

Details below drop:

Full supply discharge	= 5.5 cumec
Bed width	= 6 m
Full supply level	=11.5
Level at the top of the bank	=12.5

Bank top width is 3 m

b. Develop the following drawings:

i. Half sectional plan at foundation level and at top (15 marks)

ii. Section along the centre line of the canal (10 marks)

PART C

(Answer one full question from each module, each question carries 10 marks)

Module IV

7 **a.** Obtain an expression for principal stress at the toe of a gravity dam. (4 marks)

b. Explain elementary profile of gravity dam. How you will develop the practical profile from it? (6 marks)

OR

8 **a.** Differentiate consolidation grouting and curtain grouting. (4 marks)

b. Determine the uplift force at the base of gravity dam of base width 25 m, height of water in the u/s face = 30 m, free board 3m, top width 6 m and height of water in the d/s face = 5 m. The drainage gallery is at a distance of 5 m from the u/s end. (6 marks)

Module V

9 **a.** State the limitations of thin cylinder theory. (4 marks)

b. Explain the classification of earth dams with sketches. (6 marks)

OR

10 **a.** Explain the design features of Ogee spillway. (4 marks)

b. Explain the hydraulic and structural causes of failure of earth dams. (6 marks)