CET 396	EARTH DAMS AND EARTH RETAINING STRUCTURES	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	4	0	0	4	2019

Preamble: Goal of this course is to impart to the students, in-depth knowledge about the fundamentals of earth dams and Earth pressure theories. After this course, students will be able to analyze stability of earth dams and various types of retaining structures.

Prerequisite: CET 305 : GEOTECHNICAL ENGINEERING II

Course Outcomes: After completion of the course the student will be able to:

Course Outcome	Description of Course Outcome
CO 1	Understand the fundamentals of earth dams
CO 2	Analyze slope stability of earth dams
CO 3	Explain the basic concepts & theories of Earth pressure
CO 4	Calculate earth pressure for different types of retaining structures
CO 5	Design Rigid and Flexible Retaining Walls applying the earth pressure theories

Mapping of course outcomes with program outcomes (Minimum requirement)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	3	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	3	-	-	-	-	-	-	-	-	-	-
CO 5	2	2	3	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	10	10	20
Understand	15	15	30
Apply	25	25	50
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation (CIE) Pattern :

Attendance : 10 Marks

Continuous Assessment Test (2 numbers) : 25 Marks

Assignment/Quiz/Course project : 15 Marks

End Semester Examination (ESE) Pattern : There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

(*Questions may be framed based on the outline given under each course outcome*)

Course Outcome 1 (CO1):

1. Understand the fundamentals of earth dams
2. Understand the types of earth dams
3. Understand the parts of earth dams like central and inclined cores, filters
4. Understand the seepage analysis of earth dams

Course Outcome 2 (CO2):

1. Analyze slope stability of earth dams

Course Outcome 3 (CO3):

1. Explain the basic concepts of Earth pressure
2. Explain Rankine's and Coulomb's theories of Earth pressure
3. Explain Graphical method using Rebhan's method

Course Outcome 4 (CO4):

1. Calculate earth pressure for different types of retaining structures using Rankine's and Coulomb's theories, Graphical Method, Trial wedge method
2. Calculate earth pressure for rigid and flexible retaining walls
3. Calculate earth pressure on Braced cuts and coffer dams

Course Outcome 5 (CO5):

1. Design of gravity retaining wall &cantilever retaining walls applying the earth pressure theories
2. Design of cantilever sheet piles
3. Design of anchored sheet piles
4. Design of Coffer Dams

SYLLABUS

Module 1
Earth dams – types of dams - Selection of type of dam based on material availability - Foundation conditions and topography - Design details – crest, free board, upstream and downstream slopes, upstream and downstream slope protection – central and inclined cores - Types and design of filters - Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation
Module 2
Construction techniques of earth dams – methods of construction - Quality control Instrumentation – measurement of pore pressures - Determination of phreatic line - Stability analysis – critical stability conditions - Desired values of factor of safety for different loading conditions of dam - Evaluation of stability by Swedish Slip Circle Method and sliding wedge method under critical conditions
Module 3
Earth pressure theories – Rankine‘s and Coulomb’s earth pressure theories for cohesionless and cohesive backfills – Computation of earth pressures for various cases – inclined – with surcharge – submerged and partly submerged – stratified backfills - Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Numerical Problems - Computation of earth pressures by Trial wedge method –A mathematical approach for completely submerged and partly submerged backfills - Numerical Problems - Importance of capillarity tension in earth pressure
Module 4
Graphical methods of earth pressure computation – trial wedge method for coulomb‘s and Rankine‘s conditions, for regular and irregular ground and wall conditions -Rebhan‘s construction for active pressure - Friction circle method - Logarithmic spiral method - Design of gravity retaining wall – cantilever retaining walls - Numerical Problems - Flexible retaining structure – type and methods of construction – design strength parameters
Module 5
Safety factor for sheet pile walls – Computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – Numerical Problems - Anchored sheet piles – free earth method – fixed earth method – Rowe‘s moment reduction method - Stability of sheet piling - Diaphragm walls and coffer dams – types of diaphragm walls and their construction techniques in various soil types - Earth pressure on braced cuts and coffer dams – Design of coffer dams

Text Books :

1. Tschebotarioff G P, Foundations, Retaining and earth structures, 2nd edition, Mcgraw Hill Pub., 1973

References:

1. Clayton, Milititsky and Woods, Earth Pressure And Earth-Retaining Structures, Taylor and Francis, 1996
2. Huntington, Earth pressure on retaining walls, John Wiley and Sons, 1957
3. Prakash, Ranjan and Saran, Analysis and Design of Foundations and Retaining structures,SarithaPrakashan, Meerut, 1977
4. Bowles, Foundation Analysis and Design, 1968.
5. Jones, Earth Reinforcements and Soil structures, 1996
7. IS : 7894 – 1975, Indian Standard Code of Practice for Stability Analysis of Earth Dams

Course Contents and Lecture Schedule:

Module	Contents		Hours
1	**Module 1**		**9**
1.1	Earth dams – types of dams	CO 1	1
1.2	Selection of type of dam based on material availability	CO 1	1
1.3	Foundation conditions and topography	CO 1	1
1.4	Design details – crest, free board, upstream and downstream slopes, upstream and downstream slope protection – central and inclined cores	CO 1	2
1.5	Types and design of filters	CO 1	2
1.6	Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation	CO 1	2
2	**Module 2**		**9**
2.1	Construction techniques of earth dams – methods of construction	CO 1	1
2.2	Quality control Instrumentation – measurement of pore pressures	CO 1	1
2.3	Determination of phreatic line	CO 1	1
2.4	Stability analysis – critical stability conditions	CO 1, CO 2	2
2.5	Desired values of factor of safety for different loading conditions of dam	CO 1, CO 2	1
2.6	Evaluation of stability by Swedish Slip Circle Method and sliding wedge method under critical conditions	CO 1, CO 2	3
3	**Module 3**		**9**
3.1	Earth pressure theories – Rankine‘s and Coulomb’searth pressure theories for cohesionless and cohesive backfills – Computation of earth pressures for various cases – inclined – with surcharge – submerged and partly submerged – stratified backfills	CO 3	2
3.2	Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Numerical Problems	CO 3, CO 4	2

3.3	Computation of earth pressures by Trial wedge method – A mathematical approach for completely submerged and partly submerged backfills	CO 3	2
3.4	Numerical Problems	CO 3, CO 4	2
3.5	Importance of capillarity tension in earth pressure	CO 3	1

4	**Module 4**		**9**
4.1	Graphical methods of earth pressure computation – trial wedge method for coulomb‘s and Rankine‘s conditions, for regular and irregular ground and wall conditions -Rebhan‘s construction for active pressure	CO 3, CO 4	2
4.2	Friction circle method - Logarithmic spiral method	CO 3	2
4.3	Design of gravity retaining wall – cantilever retaining walls - Numerical Problems	CO 5	3
4.4	Flexible retaining structure – type and methods of construction – design strength parameters	CO 3	2
5	**Module 5**		**9**
5.1	Safety factor for sheet pile walls – Computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – Numerical Problems	CO3, CO 4	2
5.2	Anchored sheet piles – free earth method – fixed earth method – Rowe‘s moment reduction method	CO 3, CO 4	2
5.3	Stability of sheet piling	CO 3, CO 5	1
5.4	Diaphragm walls and coffer dams – type of diaphragm walls and their construction techniques in various soil types	CO 3	2
5.5	Earth pressure on braced cuts and coffer dams – Design of coffer dams	CO 3, CO 5	2

Model Question Paper
QP CODE:

Reg No.:_____ **Name:**_____

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

Course Code: CET396
Course Name : EARTH DAMS AND EARTH RETAINING STRUCTURES

Max. Marks: 100 Duration: 3 hours

Part A
(***Answer all questions; each question carries 3 marks***)

1. Explain types of dams
2. Explain downstream slope protection measures
3. Explain the instrumentation for quality control of dams
4. Explain critical stability conditions of dams
5. Explain critical depth for an unsupported cut in cohesive soil.
6. List the assumptions of Coulomb's theory of earth pressure
7. Differentiate between rigid and flexible retaining structures
8. Explain the methods of construction of flexible retaining structures
9. How to check the stability of sheet piling?
10. List the types of Diaphragm walls

PART B

(Answer one full question from each module, each question carries 14 marks)

Module – 1

11. (a) Explain the basic design studies necessary for design of an earth dam. (7 Marks)
    (b) Explain about the seepage through Dam and foundation. (7 Marks)
12. (a) Discuss in detail the Terzgahi's filter criteria for its design. (7 Marks)
    (b) Explain the control of seepage in earth dam. (7 Marks)

Module – 2

13. (a) Explain construction techniques of an earth dam. (7 Marks)
    (b) Explain Swedish Slip Circle method of stability analysis. (7 Marks)
14. (a) Explain methods of construction of an earth dam. (7 Marks)
    (b) Explain Sliding Wedge method of stability analysis. (7 Marks)

Module – 3

15. (a) Explain Trial wedge method of earth pressure. (5 Marks)

(b) Compute the total lateral earth thrust exerted by a layered backfill of height 10m if the wall has a tendency to move away from the backfill. The upper layer of thickness 4 m has angle of internal friction 32° and unit weight 19 kN/m^3. The lower layer has angle of internal friction 28°, cohesion 20kPa, and unit weight 18 kN/m^3. The backfill also supports a uniform surcharge of intensity $10kN/m^2$. Also find the point of application. (9 Marks)

16. (a) Explain the importance of capillary tension in computation of earth pressure (5 Marks)

(b) For a layered backfill behind a 10m high retaining wall with a smooth vertical backfill, Draw the active earth pressure distribution and its magnitude and point of application : (9 Marks)

Sl. No.	Depth	Backfill Properties
1.	0 – 3 m	$c = 30kN/m^2$, $\phi = 0°$, $\gamma = 19kN/m^3$
2.	3 – 6 m	$c = 0kN/m^2$, $\phi = 32°$, $\gamma = 18kN/m^3$
3.	6 – 10 m	$c = 50kN/m^2$, $\phi = 0°$, $\gamma = 17kN/m^3$

Module – 4

17. (a) Explain design strength parameters of a flexible retaining wall. (5 Marks)

(b) The retaining wall having 6m height having back of wall is inclined at +ve batter angle of15° and ground surface has an upward inclination of 20° retains a backfill with following properties : γ= 19kN/m3, $\phi = 34°$, $\delta = 20°$.

(i) Determine the total active thrust by Rebann's graphical construction.

(ii) A surcharge of $50kN/m^2$ is acting on the backfill. What is the magnitude of total active thrust? (9 Marks)

18. (a) Explain Logarithmic Spiral method. (5 Marks)

(b) A trapezoidal masonry retaining wall 1.5m wide at the top and 5m wide at its bottom is 5m high. The vertical face is retaining soil ($\phi = 30°$) at a surcharge angle of 15° with the horizontal. Unit weights of soil and masonry are $20kN/m^3$ and $24kN/m^3$.The coefficient of friction at the base of the wall is 0.40. Check the stability of the retaining by applying necessary checks if the soil bearing capacity is $90kN/m^2$. (9 Marks)

Module – 5

19. (a) Explain the step by step procedure for design of a diaphragm wall. (7 Marks)

(b) Describe the stability checking of sheet pile wall using fixed and free earth support methods. (7 Marks)

20. (a) What are different types of coffer dams? (5 Marks)

(b) An anchored sheet pile is to support a mass of cohesion less soil up to height of 6m above ground level with horizontal anchor toes spaced at 1m intervals and located at 1.0m below the ground surface. If the unit weight of the soil is 21kN/m^3 and its angle of internal friction is 30°, determine the minimum depth of embedment of the sheet pile for stability. (9 Marks)