Department of CIVIL ENGINEERING

Details of Lesson Plan

S.No.	Particulars	Details
1.	Course Name	Geotechnical engineering
2.	Course Code	CE-302
3.	Academic Year	2024-25
4.	Semester	5TH
5.	Number of Lesson plans	52
6.	Faculty Assigned	Iliyas Khaleel

Faculty Signature

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Lesson Plan No. 1	Course Name: Geotechnical Engineering Topic: Introduction to Stress in soils	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of stress. b. Understand concept of stress due to point load. c. illustrate stress strain parameters for different loads. d. appreciate advantages of geostatic stress including both horizontal and vertical stress.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask questions.
	    What do you mean by stress and strain?
	    What are the different types of loads?
	    What do you mean by geotechnical engineering?
	    How to draw stress strain curve?
	  - Introduce the concept of stress and strain. Show Figure on slide.
	  - Talk about the concept of stress strain in soil mechanics.
	  - Introduce the formal definition of stresses in soil.
	  - Highlight the important characteristics of geotechnical engineering.
	  - Highlight the different types of loads that are applied on soil and the stress caused by these loads.
	
	2. **Development** (30 minutes)
	  - Stress in soil.
	  - Introduction to various loads which causes stress in soil.
	  - Explain the concept of Boussinesq's equation to find out stress caused due to concentrated load.
	  - Illustrate with examples to demonstrate how point load causes vertical and horizontal stress in soil.
	  - Derive the equation for vertical and horizontal stress caused due to point load.
	  Exercise (5 minutes) – Find the Stress caused due to 5KN point load at the ground surface using Boussinesq's equation.
	    a. Problem: Calculate the stress at a specific point D which is 6m directly below load. Also calculate the vertical stress at the same point.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading

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	http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Determine the stress at a given point in the Simply supported beam by using the concept of Boussinesq's equation. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 2	Course Name: Geotechnical Engineering Topic: Stress due to line load and strip load	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the role of line and strip load.
	   b. Understand concept of stress due to line load and strip load.
	   c. Evaluation of stresses subjected to line load and strip load.
	   d. How to use Boussinesq's equation to find stresses in soil.

Teaching Aids (if any)	a. Use of chalk and black board. b. Use of Nearpod tool for online quiz
Teaching Development	- **Introduction** (5 minutes) - Start with engaging questions to prompt audience participation: - Have you studied the concept of stresses in structures? - Can you think of an example where stress is significant in a foundation? - Emphasize the importance of stress in structures. - Evaluation of stresses subjected to line load and strip load. **Development** (30 minutes) - Vertical Stress in soil. - Introduction to various loads which causes stress in soil. - Explain the concept of Boussinesq's equation to find out stress caused due to line load and strip load. - Illustrate with examples to demonstrate how point load causes stress in soil. - Derive the equation for stress caused due to line load and strip load also find out the maximum stress point. Exercise (5 minutes) – Find the Stress caused due to 5KN/m line load and strip load at 5m below the ground surface using Boussinesq's equation. Problem: Calculate the stress at a specific point D which is 3m wide and 5m below in the given foundation surface with the given loading conditions ie 500N/m
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://archive.nptel.ac.in/courses/105/103/105103207/ 3. Homework Determine the stress at a specific point D which is 3m wide and 5m deep in the given foundation surface with the given loading conditions ie 500N/m Spend 5 minutes to wrap up and consolidate the learnings

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Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing

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Lesson Plan No. 3	Course Name: Geotechnical Engineering Topic: Stresses due to uniformly loaded circular area, rectangular loaded area.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: 　a. Understand the Uniformly loaded area and rectangular loaded area. 　b. Understand concept of stress uniformly loaded area and rectangular loaded area. 　c. Evaluation of stresses subjected to uniformly loaded area and rectangular loaded area. 　d. How to use Boussinesq's equation to find stresses in soil.
Teaching Aids (if any)	a. Use of chalk and black board. 　b. Use of Nearpod tool for online quiz
Teaching Development	-　**Introduction** (5 minutes) -　Start with engaging questions to prompt audience participation: -　Have you studied the concept of stresses in structures? -　Can you think of an example where stress is significant in a foundation? -　Emphasize the importance of pressure bulb in soil. -　Evaluation of stresses subjected to uniformly loaded area and rectangular loaded area. **Development** (30 minutes) -　Vertical Stress in soil due to uniformly loaded area and rectangular loaded area. -　Vertical Stress in soil due to circular area. -　Explain the concept of Boussinesq's equation to find out stress caused due to circular area. -　Illustrate with examples to demonstrate how circular load causes stress in soil. -　Derive the equation for stress caused due to circular area UDL and rectangular area also find out the maximum stress point. Exercise (5 minutes) – Find the Stress caused due to 5KN/m UDL and 4KN rectangular load at 5m below the ground surface using Boussinesq's equation. Problem: Calculate the stress at a specific point D which is 3m wide and 5m below in the given foundation surface with the given loading conditions ie 500N/m
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://archive.nptel.ac.in/courses/105/103/105103207/ 3. Homework Determine the stress at a specific point D which is 3m wide and 5m deep in

	the given foundation surface with the given loading conditions ie 500N/m Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing

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Lesson Plan No. 4	Course Name: Geotechnical Engineering Topic: Influence factors, Isobars, Boussinesq's equation and Westergaard's theories.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the concept of Newmark's influence chart.
	   b. Understand concept of Isobars.
	   c. Evaluation of Westgard's analysis.
	   d. How to use Boussinesq's equation to find stresses in soil.

Teaching Aids (if any)	a. Use of chalk and black board. b. Use of Nearpod tool for online quiz
Teaching Development	- **Introduction** (5 minutes) - Start with engaging questions to prompt audience participation: - Have you studied the concept of Isobars? - Can you think of an example where stress is significant in a foundation? - Emphasize the importance of pressure bulb in soil. - Evaluation of stresses subjected to concentrated load by Boussinesqs equation. **Development** (30 minutes) - Isobars and their graphical representation. - Newmark's influence chart and use of it. - Comparison of stresses due to loads on areas of different shapes. - Illustrate with examples to demonstrate how Newmark's influence charts ar drawn for different shapes of foundation. - Derive the equation for stress caused due to triangular area and trapezoidal area also find out the maximum stress point. Exercise (5 minutes) – Find the Stress caused due to 5KN/m UDL and 4KN rectangular load at 5m below the ground surface using Boussinesq's equation. Problem: Calculate the stress at a specific point D which is 3m below in the given foundation surface and on the centre of embankment take density 18KN/m3.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://archive.nptel.ac.in/courses/105/103/105103207/ 3. Homework Determine the stress at a specific point D which is 5m deep in the given foundation surface with the given loading conditions ie 500N/m Spend 5 minutes to wrap up and consolidate the learnings

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Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing

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Lesson Plan No. 5	Course Name: Geotechnical Engineering Topic: Contact pressure and elastic theory	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the concept of flexible footing.
	   b. Understand concept of Rigid footing.
	   c. Evaluation of Pressure distribution.
	   d. How to use Elastic theory for pressure distribution.

Teaching Aids (if any)	a. Use of chalk and black board. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	
	  - Start with engaging questions to prompt audience participation:
	  - Have you studied the concept different types of soil?
	  - Can you think of an example of different types of footings?
	  - Emphasize the importance of pressure distribution in foundation.
	  - Evaluation of uniform pressure distribution.
	Development (30 minutes)
	
	  - Pressure distribution of flexible and rigid footings.
	  - Westgard's analysis chart and use of it.
	  - Contact pressure under clay and sand.
	  - Illustrate with examples to demonstrate how Westgard's analysis are drawn for different shapes of foundation.
	  - Limitations of Newmark's influence theory and Elastic theory.
	Exercise (5 minutes) – Draw the diagram showing contact pressure under flexible clay and sand and rigid clay and sand footing.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://archive.nptel.ac.in/courses/105/103/105103207/ 3. Homework Draw the diagram showing contact pressure under flexible clay and sand and rigid clay and sand footing. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing

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Lesson Plan No. 6	Course Name: Geotechnical Engineering Topic: Shear strength and Mohr's circle	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of shear stress in soil. b. Understand concept of principle planes major and minor principal stresses. c. illustrate Mohr's circle how to draw it. d. appreciate advantages of Mohr's circle and its uses in finding major and minor principal stresses.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	 - Ask questions.
	    What do you mean by stress and strain?
	    What are the different types of principal planes?
	    What do you mean by Mohr's circle?
	    How to draw Mohr's circle?
	 - Introduce the concept of major and minor principal stresses. Show Figure on slide.
	 - Talk about the concept of stress system with principal planes inclined to coordinate axis.
	 - Introduce the formal definition of shear stresses in soil.
	 - Highlight the important characteristics of Mohr's circle.
	 - Highlight the different types principal planes.
	
	 2. **Development** (30 minutes)
	 - Shear Stress in soil.
	 - Introduction to various types of principal planes.
	 - Explain the concept of Mohr's circle how to draw it and who to find principal planes from it.
	 - Illustrate with examples to demonstrate Mohr's circle for different conditions
	 - Derive the equation for stress system with principal planes for different conditions.
	 Exercise (5 minutes) – Find the Major and Minor principal stress for a Mohr's circle of radius 5m.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Draw Mohrs circle if sigma1 =n30KN/m3 and sigma2= 10KN/m3

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	- Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 7	Course Name: Geotechnical Engineering Topic: Major and Minor Principal stresses.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of shear stress in soil. b. Understand concept of principle planes major and minor principal stresses. c. illustrate Mohr's circle how to draw it. d. appreciate advantages of Mohr's circle and its uses in finding major and minor principal stresses.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. What do you mean by stress and strain? What are the different types of principal planes? What do you mean by Mohr's circle? How to draw Mohr's circle? - Introduce the concept of major and minor principal stresses. Show Figure on slide. - Talk about the concept of stress system with principal planes inclined to coordinate axis. - Introduce the formal definition of shear stresses in soil. - Highlight the important characteristics of Mohr's circle. - Highlight the different types principal planes. 2. **Development** (30 minutes) - Shear Stress in soil. - Introduction to various types of principal planes. - Explain the concept of Mohr's circle how to draw it and who to find principal planes from it. - Illustrate with examples to demonstrate Mohr's circle for different conditions - Derive the equation for stress system with principal planes for different conditions. Exercise (5 minutes) – Find the Major and Minor principal stress for a Mohr's circle of radius 5m.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Draw Mohrs circle if sigma1 =n30KN/m3 and sigma2=

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	10KN/m3 - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 8	Course Name: Geotechnical Engineering Topic: Mohr-Coulomb theory.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	   a. articulate the concept of Mohr-Coulomb theory.
	   b. Understand concept of revised Mohr-Coulomb theory.
	   c. illustrate the concept of cohesion and angle of friction
	   d. appreciate advantages of Mohr-Coulomb theory.

Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask questions.
	    What do you mean by failure plane?
	    What do you mean by major and minor principal plane?
	    What are the steps to draw Mohr's circle?
	    How to draw stress strain curve?
	  - Introduce the concept of Mohr-Coulomb theory.
	  - Talk about the concept of stress strain in soil mechanics.
	  - Introduce the formal definition of cohesion and angle of internal friction.
	  - Highlight the important characteristics of Mohr-Coulomb theory.
	  - Highlight the different limitations of Mohr-Coulomb theory. .
	
	2. **Development** (30 minutes)
	  - Mohr-Coulomb theory.
	  - Mohr-Coulomb failure creation and modified failure envelop
	  - Draw Mohr's circle for Mohr-Coulomb theory.
	  - Illustrate with examples to demonstrate how Mohr-Coulomb theory and its failure plane can be shown in Mohr's circle.
	  - Explain the limitations of Mohr-Coulomb theory.
	Exercise (5 minutes) – Draw the Mohr's circle if sigma1=30KN/m3 and sigma2=40KN/m3.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	  http://www.digimat.in/nptel/courses/video/105105168/L20.html
	3. Homework
	  - Draw the Mohr's circle if sigma1=30KN/m3 and sigma2=40KN/m3.Find out the max shear stress and failure envelope from it.
	Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	2. Nearpod Quiz on stresses in soil mechanics.
	Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 9	Course Name: Geotechnical Engineering Topic: Direct shear test.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of shear stress in soil. b. Understand concept of different types of drainage conditions c. illustrate Direct shear test in lab. d. appreciate advantages and limitations of Direct shear test.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	- Ask questions.
	  What do you mean shear stress?
	  What are the different types of shear tests in lab?
	  What do you mean by Mohr's circle?
	  How to draw Mohr's circle?
	- Introduce the concept of Direct shear test
	- Talk about the Limitations of direct shear test.
	- Introduce the formal definition of shear stresses in soil.
	- Highlight the important characteristics of Direct shear test.
	- Highlight the different types of drainage conditions.
	
	2. **Development** (30 minutes)
	- Shear Stress in soil.
	- Introduction to various types of shear tests in lab and field.
	- Explain the concept of Direct shear test and its failure envelope.
	- Illustrate with examples to demonstrate Direct shear test and its limitations.
	- Explain the apparatus and procedure of Direct shear test.
	Exercise (5 minutes) – Represent graphically the results of Direct shear test show its failure plane and find out the angle of cohesion.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	   http://www.digimat.in/nptel/courses/video/105105168/L20.html
	3. Homework
	   - From the direct shear test results draw Mohrs circle if sigma1 =n30KN/m3 and sigma2= 10KN/m3
	   - Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics.

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	Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 10	Course Name: Geotechnical Engineering Topic: Triaxial shear test.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of shear stress in soil. b. Understand concept of different types of drainage conditions c. illustrate Triaxial shear test in lab. d. appreciate advantages and limitations of triaxial shear test over Triaxial shear test.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. What do you mean shear stress? What are the different types of shear tests in lab? What do you mean by Mohr's circle? How to draw Mohr's circle? - Introduce the concept of Triaxial shear test - Talk about the advantages of Triaxial shear test. - Introduce the formal definition of shear stresses in soil. - Highlight the important characteristics of Triaxial shear test on cohesive and cohesionless soil. - Highlight the different types of drainage conditions. 2. **Development** (30 minutes) - Shear Stress in soil. - Introduction to various types of shear tests in lab and field. - Explain the concept of Triaxial shear test and its failure envelope. - Illustrate with examples to demonstrate Triaxial shear test and its limitations. - Explain the apparatus and procedure of Triaxial shear test. Exercise (5 minutes) – Represent graphically the results of Triaxial shear test show its failure plane and find out the angle of cohesion.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - From the Triaxial shear test results draw Mohrs circle if sigma1 =n30KN/m3 and sigma2= 10KN/m3 - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.

	2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 11	Course Name: Geotechnical Engineering Topic: Unconfined compression test.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of shear stress in soil. b. Understand concept of different types of drainage conditions c. illustrate Unconfined compression test in lab. d. appreciate advantages and limitations of Unconfined compression test over triaxial and direct shear test.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	- Ask questions.
	   What do you mean shear stress?
	   What are the different types of shear tests in lab?
	   What do you mean by Mohr's circle?
	   How to draw Mohr's circle?
	- Introduce the concept of Unconfined compression test
	- Talk about the advantages of Unconfined compression test.
	- Introduce the formal definition of shear stresses in soil.
	- Highlight the important characteristics of Unconfined compression test on cohesive and cohesionless soil.
	- Highlight the different types of drainage conditions.
	
	2. **Development** (30 minutes)
	- Shear Stress in soil.
	- Introduction to various types of shear tests in lab and field.
	- Explain the concept of Unconfined compression test and its failure envelope.
	- Illustrate with examples to demonstrate Unconfined compression test and its limitations.
	- Explain the apparatus and procedure of Unconfined compression test.
	Exercise (5 minutes) – Represent graphically the results of Unconfined compression test show its failure plane and find out the angle of cohesion.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - From the Unconfined compression test results draw Mohrs circle if sigma1 =n30KN/m3 and sigma2= 10KN/m3 - Spend 5 minutes to wrap up and consolidate the learnings

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Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 12	Course Name: Geotechnical Engineering Topic: Drainage conditions of shear tests.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	  a. articulate the concept of shear stress in soil.
	  b. Understand concept of different types of drainage conditions
	  c. illustrate confined and unconfined conditions.
	  d. appreciate advantages and limitations of Vane shear test.

Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask questions.
	    What do you mean shear stress?
	    What are the different types of shear tests in lab?
	    What do you mean by confined and unconfined condition of shear tests?
	    What do you mean by consolidation?
	  - Introduce the concept of drainage conditions of various shear tests.
	  - Talk about the advantages of vane shear test.
	  - Relation between undrained shear strength and effective overburden pressure.
	  - Highlight the important characteristics of Vane shear test.
	  - Highlight the different types of drainage conditions.
	
	2. **Development** (30 minutes)
	  - Shear Stress in soil.
	  - Introduction to various types of drainage conditions in shear tests.
	  - Explain the concept of Vane shear test.
	  - Illustrate with examples to demonstrate different drainage conditions for all shear tests.
	  - Derive the equation for vane shear test.
	Exercise (5 minutes) – Find the relationship between undrained shear strength and effective overburden pressure.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	    http://www.digimat.in/nptel/courses/video/105105168/L20.html
	3. Homework
	  - Draw Mohrs circle graph between undrained shear strength effective overburden pressure and Cu.
	  - Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to

	answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Kot Bhalwal, Jammu

Lesson Plan No. 13	Course Name: Geotechnical Engineering Topic: Lateral earth pressure at rest.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Earth pressure. b. Understand concept of different types of lateral earth pressure. c. Illustrate earth pressure at rest active earth pressure and passive earth pressure. d. Graphical representation of variation of pressure in retaining wall.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	 - Ask questions.
	   What do you mean retaining wall?
	   What are the different types of retaining wall?
	   What do you mean by Pressure?
	   What do you mean by active and passive earth pressure?
	 - Introduce the concept of Retaining wall and lateral earth pressure
	 - Talk about active and passive earth pressure.
	 - Different earth pressure at rest.
	 - Highlight the variation of earth pressure.
	 - Highlight the different types of earth pressures.
	
	 2. **Development** (30 minutes)
	 - Retaining wall and its types.
	 - Introduction to various types of Lateral earth pressure at rest.
	 - Explain the concept of active and passive earth pressure.
	 - Illustrate with examples variation of pressure in retaining walls.
	 - Derive the equation for earth pressure at rest.
	 Exercise (5 minutes) – Find the relation for total pressure at the base of retaining wall

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Determine the lateral earth pressure at rest per unit length of wall if a clay layer 2m thick of density 17KN/m3 and angle of 30 degree is sandwiched by a sand layer 3m of density 19KN/m3 and angle of 30 degree. Find out the location of resultant pressure if density of water is 10KN/m3.Water table is 2m below surface. - Spend 5 minutes to wrap up and consolidate the learnings

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Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	2. Nearpod Quiz on stresses in soil mechanics.
	Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 14	Course Name: Geotechnical Engineering Topic: Rankine's theory.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Earth pressure. b. Understand concept of different types of lateral earth pressure. c. Illustrate earth pressure at rest active earth pressure and passive earth pressure. d. Graphical representation of variation of pressure in retaining wall.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	- Ask questions.
	  What do you mean retaining wall?
	  What are the different surfaces of retaining wall?
	  What do you mean by cohesion?
	  What do you mean by active and passive earth pressure?
	- Introduce the concept of angle of internal friction pressure
	- Talk about active and passive earth pressure.
	- Different earth pressure at rest.
	- Highlight the importance of Rankine's theory.
	- Rankine's earth pressure when surface is inclined.
	
	2. **Development** (30 minutes)
	- Rankine's theory and its applications.
	- Introduction to various limitations of Rankine's theory.
	- Explain the concept of active and passive earth pressure using Rankine's theory.
	- Illustrate with examples Rankine's theory in cohesion and cohesionless soils.
	- Derive the equation for active and passive earth pressure using Rankine's theory.
	Exercise (5 minutes) – Find the relation for total pressure at the base of retaining wall

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Draw pressure distribution diagram for various earth pressures. - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.

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| | 2. Nearpod Quiz on stresses in soil mechanics. |
| | Spend 5 minutes to evaluate student assimilation of the lesson contents |

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Model Institute of Engineering
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Lesson Plan

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Kot Bhalwal, Jammu

Lesson Plan No. 15	Course Name: Geotechnical Engineering Topic: Active and Passive earth pressure.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Earth pressure. b. Understand concept of different types of lateral earth pressure. c. Illustrate earth pressure at rest active earth pressure and passive earth pressure. d. Graphical representation of variation of pressure in retaining wall.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. What do you mean retaining wall? What are the different surfaces of retaining wall? What do you mean by cohesion? What do you mean by active and passive earth pressure? - Introduce the concept of angle of internal friction pressure - Talk about active and passive earth pressure. - Different earth pressure at rest. - Highlight the importance of angle of cohesion in soil. - Rankine's earth pressure for cohesion and cohesionless soils. 2. **Development** (30 minutes) - Active and passive earth pressure. - Introduction to various limitations of Rankine's theory. - Explain the concept of active and passive earth pressure using Rankine's theory. - Illustrate with examples Rankine's theory in cohesion and cohesionless soils. - Derive the equation for active and passive earth pressure using Rankine's theory. Exercise (5 minutes) – Find the relation for total pressure at the base of retaining wall
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Draw pressure distribution diagram for various earth pressures. - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.

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	2. Nearpod Quiz on stresses in soil mechanics.
	Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 16	Course Name: Geotechnical Engineering Topic: Stability of slopes.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept slope in soil mechanics. b. Understand importance of stability of slopes. c. Illustrate with examples stability of slopes in canals highways dams and retaining walls. d. Different factor of safety in stability of slopes.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask questions.
	    How is railway embankment formed?
	    What do you mean by slope of soil?
	    What do you mean by shear strength of soil?
	    What are the factors affecting shear strength of soil?
	  - Introduce the concept of stability of soil?
	  - Talk about various uses of slope stability in engineering.
	  - Different earth pressure at rest.
	  - Highlight the importance of angle of cohesion in soil.
	  - Rankine's earth pressure for cohesion and cohesionless soils.
	
	2. **Development** (30 minutes)
	  - Stability of slopes in highway railways and canals.
	  - Different definitions of factors of safety used in soil stability.
	  - Explain the various types of soil failures
	  - Illustrate with examples uses of soil stability in civil engineering.
	  - Derive the equation for various factor of safety in soil stability.
	Exercise (5 minutes) – Determine FOS for long natural slope in over consolidated clay c=10KN/m2 and fi=25 degree unit weight saturated =20KN/m2 is inclined at 10 degree to horizontal?

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	http://www.digimat.in/nptel/courses/video/105105168/L20.html
	3. Homework
	  - Find FOS for different angle and unit weight of soil?.
	  - Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics.

Lesson Plan No. 16	Course Name: Geotechnical Engineering Topic: Types of slopes and their failure mechanism.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	    a. articulate the concept slope in soil mechanics.
	    b. Understand types of slopes and their failure.
	    c. Illustrate with examples stability of slopes in canals highways dams and retaining walls.
	    d. Stability of infinite slope of cohesionless soil.
	    e. Stability of infinite slope of cohesive soil.

Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	- Ask questions.
	    How is railway embankment formed?
	    What do you mean by slope of soil?
	    What do you mean by shear strength of soil?
	    What are the factors affecting shear strength of soil?
	- Introduce the concept of stability of soil?
	- Talk about various uses of slope stability in engineering.
	- Different types of slopes and their failure mechanism
	- Highlight the importance of angle of cohesion in soil.
	- Stability of infinite slope of cohesionless soil
	- Stability of infinite slope of cohesive soil
	- **Development** (30 minutes)
	- Stability of slopes in highway railways and canals.
	- Stability of infinite slope of cohesionless soil.
	- Stability of infinite slope of cohesive soil.
	- Explain the various types of soil failures
	- Illustrate with examples uses of soil stability in civil engineering.
	- Derive the equation for cohesive and cohesionless soil stability.
	Exercise (5 minutes) – Determine FOS for long natural slope in over consolidated clay c=10KN/m2 and fi=25 degree unit weight saturated =20KN/m2 is inclined at 10 degree to horizontal?

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	    http://www.digimat.in/nptel/courses/video/105105168/L20.html
	3. Homework
	    - Find wedge failure of soil and derive its equation?.
	    - Spend 5 minutes to wrap up and consolidate the learnings

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	2. Nearpod Quiz on stresses in soil mechanics.
	Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 18	Course Name: Geotechnical Engineering Topic: Analysis of finite and infinite slope.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	   a. articulate the concept slope in soil mechanics.
	   b. Stability of finite slope of cohesionless soil.
	   c. Stability of finite slope of cohesive soil.
	   d. Stability of infinite slope of cohesionless soil.
	   e. Stability of infinite slope of cohesive soil.

Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	- Ask questions.
	   How is railway embankment formed?
	   What do you mean by slope of soil?
	   What do you mean by shear strength of soil?
	   What are the factors affecting shear strength of soil?
	- Introduce the concept of stability of soil?
	- Talk about various uses of slope stability in engineering.
	- Stability of finite slope of cohesive soil.
	   Stability of infinite slope of cohesionless soil.
	- Stability of infinite slope of cohesive soil
	- Stability of infinite slope of cohesive soil
	- **Development** (30 minutes)
	- Stability of slopes in highway railways and canals.
	- Stability of infinite slope of cohesionless soil.
	- Stability of infinite slope of cohesive soil.
	- Explain the various types of soil failures
	- Illustrate with examples uses of soil stability in civil engineering.
	- Derive the equation for cohesive and cohesionless soil stability.
	Exercise (5 minutes) – Determine FOS for long natural slope in over consolidated clay c=10KN/m2 and fi=25degree unit weight saturated =20KN/m2 is inclined at 10 degree to horizontal?

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Find wedge failure of soil and derive its equation?. - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to

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	answer and discuss.
	2. Nearpod Quiz on stresses in soil mechanics.
	Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 19	Course Name: Geotechnical Engineering	Course No.: CE-302
	Topic: Friction circle method	

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept slope in homogeneous soils. b. Stability of dry soil and submerged soil. c. Stability of slope under sudden drawdown condition. d. Stability of slope under steady seepage condition. e. Stability of slope during construction.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	 - Ask questions.
	   How is construction slope formed?
	   What do you mean by dry and submerged soil?
	   What do you mean by seepage of soil?
	   What are the factors affecting shear strength of soil?
	 - Introduce the concept of stability of homogeneous soil?
	 - Talk about Stability of dry soil and submerged soil.
	 - Stability of slope under sudden drawdown condition.
	 - Stability of slope under steady seepage condition.
	 - Stability of slope during construction
	 - Stability of infinite slope of cohesive soil
	 - **Development** (30 minutes)
	 - Stability of slope under sudden drawdown condition.
	 - Stability of slope under steady seepage condition.
	 - Stability of slope during construction.
	 - Explain the various types of soil failures
	 - Illustrate with examples uses of soil stability in civil engineering.
	 - Derive the equation for friction circle method for stability of dry and submerged soil.
	
	 Exercise (5 minutes) – Determine FOS using friction circle method for long natural slope in over consolidated clay c=10KN/m2 and fi=25degree unit weight saturated =20KN/m2 is inclined at 10 degree to horizontal?

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	 2. Suggested Reading
	   http://www.digimat.in/nptel/courses/video/105105168/L20.html
	 3. Homework
	   - Find wedge failure of soil and derive its equation?.
	   - Spend 5 minutes to wrap up and consolidate the learnings

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Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	2. Nearpod Quiz on stresses in soil mechanics.
	Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 20	Course Name: Geotechnical Engineering Topic: Site investigation and soil exploration	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept site selection. b. Factors affecting site selection. c. Planning of civil engineering site. d. Stages in sub surface exploration. e. Depth of exploration.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	 - Ask questions.
	   What is construction site?
	   How is construction site choosing for project?
	   What are the factors that affects the site selection?
	   What are the factors affecting depth of exploration?
	 - Introduce the concept of site investigation and soil exploration?
	 - Talk about planning a subsurface exploration programme.
	 - Stages in sub surface exploration and detailed exploration
	 - Reconnaissance survey in soil exploration.
	 - Depth of exploration for different conditions.
	 - Lateral extent of exploration and methods of exploration.
	 - **Development** (30 minutes)
	 - Introduce the concept of site investigation and soil exploration. Open excavation methods of exploration.
	 - Borings for exploration and its different methods.
	 - Explain the various types of soil samplers.
	 - Illustrate with examples uses of site investigation in civil engineering.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Find the area ratio inside clearance and outside clearance of sample?. - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 21	Course Name: Geotechnical Engineering Topic: Methods of soil exploration	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	   a. articulate the concept site selection.
	   b. Factors affecting site selection.
	   c. Planning of civil engineering site.
	   d. Stages in sub surface exploration.
	   e. Depth of exploration.

Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	- Ask questions.
	  What is construction site?
	  How is construction site choosing for project?
	  What are the factors that affects the site selection?
	  What are the factors affecting depth of exploration?
	- Introduce the concept of site investigation and soil exploration?
	- Talk about planning a subsurface exploration programme.
	- Stages in sub surface exploration and detailed exploration
	- Reconnaissance survey in soil exploration.
	- Depth of exploration for different conditions.
	- Lateral extent of exploration and methods of exploration.
	- **Development** (30 minutes)
	- Introduce the concept of site investigation and soil exploration. Open excavation methods of exploration.
	- Borings for exploration and its different methods.
	- Explain the various types of soil samplers.
	- Illustrate with examples uses of site investigation in civil engineering.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Find the area ratio inside clearance and outside clearance of sample?. - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 22	Course Name: Geotechnical Engineering Topic: Cone penetration test.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. Procedure of Static cone penetration test. b. Procedure of dynamic cone penetration test. c. Procedure of Vane shear test. d. Uses of Static cone penetration test. e. Uses of dynamic cone penetration test.
Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	- Ask questions.
	   What is insitu and lab test?
	   How is construction site choosing for project?
	   What are the factors that affects the site selection?
	   What are the factors affecting depth of exploration?
	- Introduce the concept of site investigation and soil exploration?
	- Talk about planning a subsurface exploration programme.
	- Stages in sub surface exploration and detailed exploration
	- Reconnaissance survey in soil exploration.
	- Depth of exploration for different conditions.
	- Lateral extent of exploration and methods of exploration.
	- **Development** (30 minutes)
	- Introduce the concept of Static cone penetration test.
	- Introduce the concept of dynamic cone penetration test.
	- Introduce the concept of Insitu vane shear test.
	- Explain the various uses of cone penetration test.
	- Illustrate with examples uses of cone penetration test in site investigation.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading http://www.digimat.in/nptel/courses/video/105105168/L20.html 3. Homework - Prepare a DPR of soil exploration report?. - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 23	Course Name: Geotechnical Engineering Topic: Standard penetration test.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	  a. Procedure of Standard penetration test.
	  b. Corrections for Standard penetration test.
	  c. Procedure of Vane shear test.
	  d. Uses of Standard penetration test.
	  e. Corelation between loose and dense soil.

Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	- Ask questions.
	  What is the difference between loose and dense soil?
	  What is the difference between soft and hard soil?
	  What are the factors that affecting the penetration of soil?
	  What are the factors affecting depth of exploration?
	- Introduce the concept of site investigation and soil exploration?
	- Talk about planning a subsurface exploration programme.
	- Stages in sub surface exploration and detailed exploration
	- Reconnaissance survey in soil exploration.
	- Depth of exploration for different conditions.
	- Lateral extent of exploration and methods of exploration.
	- **Development** (30 minutes)
	- Introduce the concept of Standard penetration test.
	- Introduce the concept of corrections in Standard penetration test.
	- Introduce the concept of Insitu vane shear test.
	- Explain the various uses of Standard penetration test.
	- Illustrate with examples uses of Standard penetration test in site investigation.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	  http://www.digimat.in/nptel/courses/video/105105168/L20.html
	3. Homework
	  - Prepare a DPR of soil exploration report?.
	  - Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 24	Course Name: Geotechnical Engineering Topic: Types of samplers.	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	  a. Design feature affecting the sample disturbance.
	  b. Split spoon sampler its drawing and uses.
	  c. Scraper bucket sampler its drawing and its uses.
	  d. Shelby tubes and thin-walled sampler and their advantages.
	  e. Piston and Denison sampler.

Teaching Aids (if any)	a. Chalk and talk. b. Use of Nearpod tool for online quiz

Teaching Development	- **Introduction** (5 minutes)
	- Ask questions.
	  What is disturbed sample?
	  How is construction site choosing for project?
	  What do you mean by undisturbed sample?
	  What are the uses of disturbed and undisturbed sample?
	- Introduce the concept of samplers used in construction site?
	- Split spoon sampler its drawing and uses.
	- Scraper bucket sampler its drawing and its uses.
	- Shelby tubes and thin-walled sampler and their advantages.
	- Piston and Denison sampler.
	- **Development** (30 minutes)
	- Split spoon sampler its drawing and uses.
	- Scraper bucket sampler its drawing and its uses.
	- Shelby tubes and thin-walled sampler and their advantages.
	- Piston and Denison sampler.
	- Illustrate with examples uses of samplers in civil engineering.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	http://www.digimat.in/nptel/courses/video/105105168/L20.html
	3. Homework
	  - Find the advantages of disturbed and undisturbed sample?
	  - Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on stresses in soil mechanics. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 25	Course Name: Structural Analysis-I Topic: Eccentrically Loaded Columns	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the behavior of eccentrically loaded columns.
	   b. Calculate stress distribution in eccentrically loaded columns.

Teaching Aids (if any)	a. Diagrams illustrating eccentric loading. b. Stress distribution charts for eccentrically loaded columns.
Teaching Development	**Introduction** (5 minutes) • Recap previous lessons on columns. • Introduce eccentric loading and its impact on column behavior. **Development (30 minutes)** • Explain eccentric loading and its effects. • Discuss the calculation of stress distribution in eccentrically loaded columns. • Solve numerical examples involving eccentrically loaded columns. Exercise (5 minutes) –Calculate the stress distribution for a given eccentrically loaded column(take any example from textbook) Problem: A steel column with a cross-sectional area of 1800 mm² and a length of 4 meters is subjected to an axial load of 300 kN with an eccentricity of 50 mm. Calculate the maximum and minimum stress in the column section.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://archive.nptel.ac.in/courses/105/105/105105162/ 3. Homework Analyze a real-world column subjected to eccentric loading.
Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 26	Course Name: Structural Analysis-I Topic: Laterally Loaded Columns	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	    a. Understand the behavior of laterally loaded columns.
	    b. Apply relevant equations to calculate deflection and stress.

Teaching Aids (if any)	a. Diagrams showing lateral loads on columns. b. Derivation of deflection equations on the board.

Teaching Development	**Introduction** (5 minutes)
	• Discuss different loading conditions for columns.
	• Introduce lateral loads and their significance.
	Development (30 minutes)
	• Explain the behavior of columns under lateral loads.
	• Derive equations for deflection and stress in laterally loaded columns.
	• Solve numerical examples involving lateral loads.
	
	Exercise (5 minutes) –**Calculate the deflection of a laterally loaded column subjected to the following load conditions:**
	    • **Load**: P =10 kN
	    • **Length of the column**: L=4 m
	    • **Moment of inertia of the column's cross-section**: I=200 cm^4
	    • **Modulus of elasticity**: E=200 GPa
	Determine the maximum deflection of the column at the point of loading.
	
	Problem: A column with a height of 5 meters is subjected to a lateral load of 15 kN at its midpoint. The column has a moment of inertia of 100×10^6 mm⁴ and a modulus of elasticity of 210 GPa. Calculate the maximum deflection of the column.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	    https://archive.nptel.ac.in/courses/105/105/105105162/
	3. Homework
	    "Given a column with a height of 4 meters, a moment of inertia of 1×10−6 m^4 and subjected to a lateral load of 500 N at the top, calculate the deflection of the column at the top under the given load, assuming it is fixed at the base."

Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 27	Course Name: Structural Analysis-I Topic: Principle of Virtual Work	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the principle of virtual work.
	   b. Apply the principle to calculate deflections in structural systems.

Teaching Aids (if any)	a. Visual aids illustrating the principle of virtual work. b. Step-by-step derivation of virtual work equations.
Teaching Development	**Introduction** (5 minutes) • Recap basic concepts in structural analysis. • Introduce the principle of virtual work and its relevance. **Development (30 minutes)** • Explain the principle of virtual work in detail. • Derive equations for calculating deflections using virtual work. • Solve examples involving the application of virtual work to calculate deflections. Exercise (5 minutes) –Calculate the deflection of a truss joint using the principle of virtual work. Problem: Calculate the vertical deflection at the joint of a simple determinate truss using the principle of virtual work. The truss is loaded with a vertical force of 10 kN at the joint. The length of each member is 4 meters, and the modulus of elasticity is 200 GPa.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	   https://archive.nptel.ac.in/courses/105/105/105105162/
	3. Homework
	To illustrate the application of the principle of virtual work to analyze a frame, let's consider a simple example. Assume we have a frame with the following configuration:
	
	Frame Description:
	• **Frame Type:** Simply supported at A and B.
	• **Dimensions:** Length of the horizontal beam = L,
	• height of the vertical member = h.
	• **Loads:**
	  ▪ Vertical point load PPP applied at the midpoint of the beam.
	  ▪ Vertical point load FFF applied at the top of the vertical member.
	• **E:** Young's modulus of the material.
	• **I:** Moment of inertia of the beam.
	Determine the deflection at the point of load PPP using the principle of virtual work

Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 28	Course Name: Structural Analysis-I Topic: Maxwell's Reciprocal Theorem	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	    a. Understand the principle of virtual work.
	    b. Apply the principle to calculate deflections in structural systems.

Teaching Aids (if any)	a. Visual aids illustrating Maxwell's reciprocal theorem. b. Examples of reciprocal forces in structures.
Teaching Development	**Introduction** (5 minutes) • Recap the principle of virtual work. • Introduce Maxwell's reciprocal theorem and its application. **Development (30 minutes)** • Explain Maxwell's reciprocal theorem in detail. • Derive relevant equations and apply them to solve structural deflection problems. • Solve examples involving reciprocal forces. Exercise (5 minutes) –Analyze the deflection in a structure using Maxwell's reciprocal theorem. Problem: For a simple beam supported at both ends with a length of 6 meters, apply Maxwell's reciprocal theorem to calculate the deflection at the midpoint due to a 20 kN load applied 2 meters from one end.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	    https://archive.nptel.ac.in/courses/105/105/105105162/
	3. Homework
	    Apply Maxwell's reciprocal theorem to analyze deflection in a truss.

Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 29	Course Name: Structural Analysis-I Topic: First Theorem of Castigliano	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to:
	  a. Understand the first theorem of Castigliano.
	  b. Apply Castigliano's theorem to calculate deflections in structures.

Teaching Aids (if any)	a. Visual aids illustrating Maxwell's reciprocal theorem. b. Examples of reciprocal forces in structures.
Teaching Development	**Introduction** (5 minutes) • Recap previous methods for deflection calculation. • Introduce Castigliano's first theorem. **Development (30 minutes)** • Explain the first theorem of Castigliano in detail. • Derive relevant equations. • Solve examples involving the application of the theorem to calculate deflections in trusses and frames. Exercise (5 minutes) –Apply Castigliano's theorem to solve a deflection problem in a given truss (Take an example of truss from a textbook) Problem: Using Castigliano's theorem, calculate the horizontal deflection at the top of a triangular truss subjected to a horizontal load of 15 kN at the top joint. The length of each truss member is 3 meters, and the modulus of elasticity is 210 GPa.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://archive.nptel.ac.in/courses/105/105/105105162/ 3. Homework Apply the first theorem of Castigliano to solve a deflection problem in a frame.
Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 30	Course Name: Structural Analysis-I Topic: Thin Cylinders: Circumferential and Longitudinal Stresses	Course No.: CE-302

Objectives	At the end of the lesson the student shall be able to: a. Understand the stress distribution in thin cylinders. b. Calculate circumferential and longitudinal stresses in thin cylinders. c. Apply these calculations to practical engineering problems. d. Solve numerical problems involving thin cylinders under different loading conditions.
Teaching Aids (if any)	a. Visual aids for stress distribution in thin cylinders. b. Interactive simulations for stress calculations.
Teaching Development	**Introduction** (5 minutes) -Engage students with questions about the behavior of thin cylinders under load. -Discuss the importance of understanding circumferential and longitudinal stresses. **Development (30 minutes)** -Define circumferential and longitudinal stresses in thin cylinders. - Explain how to calculate these stresses using appropriate formulas. - Provide examples and numerical practice problems. Exercise (5 minutes) – Calculate circumferential and longitudinal stresses for a given thin cylinder problem. Problem: A thin cylindrical shell with a radius of 1 meter and wall thickness of 5 mm is subjected to an internal pressure of 2 MPa. Calculate the circumferential and longitudinal stresses in the cylinder.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://archive.nptel.ac.in/courses/112/107/112107146/ 3. Homework **Internal Pressure** **Given:** A thin-walled cylindrical vessel with an internal radius r =500 mm and a wall thickness t=10 mm. The vessel is subjected to an internal pressure p=2 MPa. **Calculate:** 1. The hoop stress (circumferential stress). 2. The longitudinal stress.
Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Nearpod Quiz on Cloud Computing Spend 5 minutes to evaluate student assimilation of the lesson contents

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