SEMESTER II

Discipline:CIVIL ENGINEERING

Stream : CE3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222TCE100	ADVANCED NUMERICAL METHODS	DISCIPLINE CORE 2	3	0	0	3

Preamble: For solving complex problems in mechanics and engineering, a post-graduate student must be well versed in numerical methods along with skills to apply them. This course equips the student with various numerical techniques that finds applications in civil engineering, across various streams (specialisations). Special focus is given to finite element method, explaining the relevance, versatility and fundamental concepts of this numerical tool.

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

CO 1	Obtain the solution of simultaneous Linear system of equations
CO 2	Obtain the numerical solutions of ordinary differential equations
CO 3	Obtain the numerical solutions for solving boundary value problems of partial differential equations
CO 4	Describe the terminologies, applications or procedure of finite element method
CO 5	Describe or apply the concept of finite element method

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3			3			
CO 2	3			3			
CO 3	3			3			
CO 4	1		2	2	2	2	
CO 5	3			2	2	2	

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	25
Analyse	25
Evaluate	5
Create	5

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (Minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

Note: Enough opportunity to explore the practical examples from specialization should be given to the students. One assignment/course project should be based on the coding or use of packages

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Model Question Paper

QP CODE:

Reg No.:_____

Name:_____ ___

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER M.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: XXXXXX

ADVANCED NUMERICAL METHODS

Max. Marks: 60 Duration: 2.5 hours

PART A

(Answer ***ALL*** questions; each question carries 5 marks)

1. Explain the procedure of solution of Tridiagonal systems
2. Explain single shooting method for solving Boundary value problems
3. Explain the parabolic and elliptic partial differential equations with examples
4. Explain any five practical applications of Finite element in the con
5. Explain Generalised coordinates and Natural coordinates in Finite Element analysis

PART B

(Answer ***any FIVE*** questions; each question carries 7 marks)

6. Solve the system of equations by Jacobi's iteration considering initial approximation as $[0.5, -0.5, 0.5]^T$

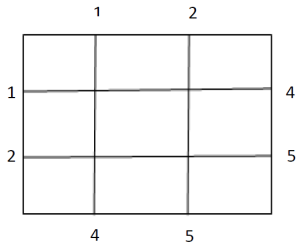
$$4x_1 + x_2 + x_3 = 2$$

$$x_1 + 5x_2 + 2x_3 = -6$$

$$x_1 + 2x_2 + 3x_3 = -4$$

7. Solve $y'=x^2+y$ for y=0.1, given that $y(0)=1$ considering h=0.05 using (i) Eulers method and (ii) Runge Kutta method

8. Solve the equation $uxx + uyy = 0$ for the square mesh with boundary value as shown in figure



9. Solve $\left(\frac{\partial u}{\partial t}\right)=\left(\frac{\partial^2 u}{\partial x^2}\right)$ subject to the conditions $u(x,0)=\sin(\pi x)$ for $0 \le x \le 1$ $u(0, t)=u(1, t)=0$. Perform the computations of two levels taking $h=1/3$ and $t=1/36$ using Crank Nicolson implicit scheme

10. Explain in detail the steps of finite element analysis

11. Explain forms of shape functions in finite element analysis

12. Explain the convergence criteria in finite element applications in detail

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Syllabus

Module 1 **(7 hours)**

Solutions of simultaneous Linear Systems of Equations- Solution of linear systems – Direct methods, Gauss-Jordan Method-Method of factorization- Solution of Tridiagonal Systems. Solution by matrix decomposition Iterative methods: Jacobi, Gauss-Siedel iteration for ordinary and sparse systems, Convergence of iterative solution schemes with examples.

Module 2 **(7 hours)**

Solving Ordinary Differential Equations- The Elementary Theory of Initial-Value Problems -Euler's Method- Higher-Order Taylor Methods. Runge-Kutta Method- Introduction to solution methods for differential algebraic equations- Single shooting method for solving ODE-BVPs.

Module 3 **(7 hours)**

Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method. Crank-Nicholson implicit method - Ellipse equations- Finite difference method-Problems with irregular boundaries.

Module 4 **(7 hours)**

Introduction to Finite Element Method – Historical Background — Mathematical Modeling of field problems in Engineering — Governing Equations — Discrete and continuous models — Boundary, Initial and Eigen Value problems– Basic concepts of the Finite Element Method- Displacement approach-Concept of Stiffness Matrix and Boundary Condition-- General procedure of FEA

Module5 **(7 hours)**

Concept of Finite Element Method- Concept of Nodes, elements, Generalised coordinates and Natural coordinates in FEA. Shape functions – Polynomials - Lagrangian and Hermitian Interpolation –- Compatibility - C0 and C1 elements - Convergence criteria - Conforming & nonconforming elements. Development of element matrices for one dimensional elements.

Text Books

1.Gupta,S.K. Numerical Methods for Engineers. Wiley Eastern, New Delhi, 1995.

2. Cook, RD. Concepts and Applications of Finite Element Analysis , Wiley.

Reference Books

1. Gilbert Strang, Linear Algebra and its Applications (4th Ed.), Wellesley Cambridge Press 2009

2. Gourdin, A. and M Boumhrat. Applied Numerical Methods.Prentice Hall India, New Delhi 2000

3. Chopra S.C. and Canale R.P. Numerical Methods for Engineers,McGraw Hill 2006

4. Krishnamoorthy C S, *Finite Element Analysis- Theory and Programming*, Tata McGraw Hill, New Delhi., 1994

5. Rao, SS. Finite Element Analysis, Elsevier Butterworth-Heinemann

6. Gerald and Wheatly, *Applied Numerical Analysis,* Pearson Education.

7. Rajasekharan S., *Numerical Methods in Science and Engineering,* S Chand & Company, 2003.

8. Bathe K J, *Finite Element Procedures in Engineering Analysis*, Prentice Hall, New Delhi. 1982

9. Chandrupatla T R and Belegundu A D, *Introduction to Finite Elements in Engineering*, Pearson Education, New Delhi 1998

10. Rajasekharan S, *Finite Element Analysis in Engineering Design*, Wheeler, New Delhi

11. Hutton D V, *Fundamentals of Finite Element Analysis*, Tata McGraw Hill Education Private Ltd, New Delhi

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CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222TCE003	EARTH RETAINING STRUCTURES	PROGRAM CORE 3	3	0	0	3

Preamble: To equip the learners to analyze and design various structures retaining soil by considering the mechanism of loads, soil properties, and load-deformation behavior.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.After the completion of the course, the student will be able to

CO 1	Determine the lateral earth pressure under various influencing factors
CO 2	Analyze and design Sheet pile walls and Bulkheads
CO 3	Analyze the stability of braced excavations and develop the pressure distribution diagrams
CO 4	Analyze and design earth retaining structures for their stability and safety
CO 5	Understand the various nonconventional retaining methods and judge its suitability for applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	2	2	2	2
CO 2	3	2	2	3	3	2	2
CO 3	2	2	3	2	2	3	2
CO 4	3	2	2	2	3	3	2
CO 5	3	3	3	2	3	3	2
CO 6	3	2	3	3	2	3	2

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	50%
Analyse	30%
Evaluate	20%
Create	00%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 4 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 5 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 8 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question paper

APJ Abdul Kalam Technological University

M.Tech Degree Examination

Branch: Geotechnical Engineering

Course Code &Name : Earth Retaining Structures

Time: 2.5 Hrs Max. Marks: 60

PART A

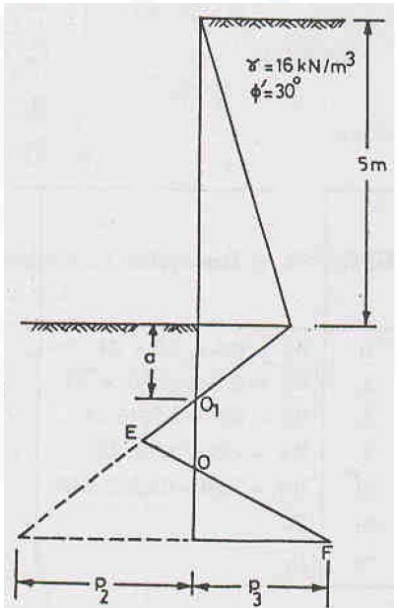
Answer All Questions. Each question carries 4 marks

1. With neat sketch, differentiate between the behavoiur of Buttress and Counterfort retaining walls.
2. Draw a typical earth pressure distribution for a cantilever sheet pile wall in cohesionless soil.
3. List the types of coffer dams with sketches.
4. Explain the role of relieving shelves in a cantilever retaining wall, with a figure.
5. With a neat set of sketches, write a note on ensuring pore water dissipation in retaining wall backfill.

PART B

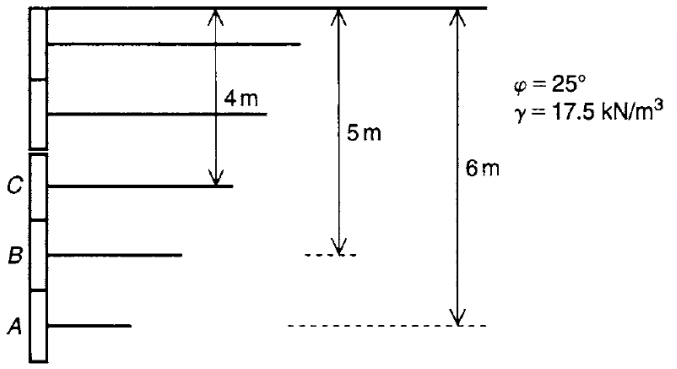
Each question carries 10 marks

6. A retaining wall 8 m height with a smooth vertical back retains the following materials: Top 2 m: Clay γ_s= 17.5 kN/m^3; φ = 0 and c = 10 kN/m^2 Bottom 6 m: saturated sand of γ_s = 19.5 kN/m^3 and φ = 30° . If the water level is on top of the sand layer, draw the diagram of lateral pressure on the wall assuming that no tension crack develops on the top layer.
7. Determine the required depth of penetration for the cantilever sheet pile shown in figure, assuming the unit weight of soil as 16kN/m^3



8. A cut 3 m wide and 15 m deep is proposed in cohesionless soil with γ = 20 kN/m3, φ = 30° and c = 0. Assuming the struts are placed with the first strut at 0.5 m below ground level and the subsequent struts at every 1.5 m below, find the maximum load on the strut. Assume, the horizontal spacing of strut is 3 m.

9. With neat sketch, design and mark the dimensions of a 6m high cantilever retaining wall to retain a cohesionless backfill soil of unit weight 18kN/m3 and angle of internal friction 30 degrees. Check the stability against sliding, overturning and bearing capacity failure if the soil beneath the base is assumed to have a safe bearing capacity of 200kPa.
10. Find the length of metal strips A, B, and C in Fig. 17.4. The density, γ of the soil is found to be 17.5 kN/m^3, and the friction angle, φ, of the soil is 25 degrees. The facing units are 1 m x I m and the metal strips are 0.5 m wide. Find the length of the metal strips if the required factor of safety is 2.5.



Syllabus and Course Plan

(For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

No	Topic	No. of Lectures
1	**Lateral Earth Pressure and Retaining walls**	
	Lateral Earth Pressure -Stress conditions in a soil mass	1
	Plastic State of equilibrium-earth pressure theories-Rankine's & Coulombs Trial wedge	2
	Effect of point loads - surcharge, groundwater table, the effect of soil tension.	1
	Numerical Problems	2
	Externally Stabilized and Internally Stabilized Earth retaining structures- Difference in the mechanism.	1
	Principles of design of retaining walls	1
	Types of Retaining walls and their differences-Gravity Retaining Walls, Cantilever Retaining walls, Counterfort and Buttress retaining wall	1
		9
2	**Flexible Retaining Structures—Sheet Pile Walls and Bulkheads**	
	Sheet Piles – Types of Sheet Pile Walls, Cantilever Sheet Pile Walls, and Anchored Sheet Pile Walls.	1
	Design- Numerical Problems	2
	conditions of end supports and distribution of earth pressure, bulkheads with free and fixed earth supports –.	2
	equivalent beam method – improvements suggested by Rowe - Tschebotarioff's method –	2
	anchorage of bulkheads and resistance of anchor walls	1
		8
3	**Braced excavation**	
	Braced excavation: Different types and Construction Methods-	1
	Pressure distribution on sheetings in sands and clays	2
	– Design of Struts and Wales, stability - Earth pressure against bracings in cuts -	1
	Numerical Problems	2
	bottom heave – seepage- Heave of the bottom of the cut in soft clays.	2
	Coffer dams- Types only	1
		9
4	**Retaining Structures- Cantilever Retaining Walls**	
	Cantilever Retaining Wall- Proportioning,	1
	Numerical Problem	1
	Structural design of Cantilever retaining walls	1
	Gravity Retaining walls- Proportioning-	1

	Factor of Safety against Sliding, Overturning, and bearing capacity failure.	2
	Mechanically Stabilized Walls- Application of Geosynthetics.	2
	Cantilever retaining walls with relieving shelves	1
		9
5	**Nonconventional retaining methods**	
	Diaphragm Walls- Applications	1
	Prestressed Ground Anchors- Applications	1
	Nonconventional retaining structures-Secant Piles, Tangent Piles, Gabion Walls (Brief explanation only)	2
	Reinforced Earth Walls- Design	2
	Drainage of RCC Retaining wall backfill	1
	Soil Anchors and Soil Nails- Mechanical and Grouted Anchors, - Applications	1
		8

Reference Books

1. Terzagi K and R.B Peck ,Soil Mechanics in Engineering Practice , John Wiley.
2. Bowles, J. E. (1988). *Foundation analysis and design*. Tata Mc Graw Hill
3. Tschebotarioff ,G.P.,Foundations , Retaining and Earth Structures, Mc Graw Hill.
4. Nainan P Kurian, Design of Foundation Systems : Principles and Practices, Narosa Publishing house.
5. Gopal Ranjan, Rao, A.S.R. ,Basic and Applied Soil Mechanics, New Age International Pvt. Ltd
6. Bolton, M.D. A Guide to Soil Mechanics, Universities Press (India) Pvt. Ltd,
7. PasswellG,Retaining Walls: Their Design and Construction, BiblioBazaar, LLC.
8. Murthy , V.N.S. ,Geotechnical Engineering : Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press.

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222PCE100	MINI PROJECT	PROJECT	0	0	4	2

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem solving skills.

The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with PG Programme Coordinator that should lead to their dissertation/research project. Demonstrate the novelty of the project through the results and outputs.The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Evaluation Committee - Programme Coordinator, One Senior Professor and Guide.

Sl. No	Type of evaluations	Mark	Evaluation criteria
1	Interim evaluation 1	20	
2	Interim evaluation 2	20	
3	Final evaluation by a Committee	35	Will be evaluating the level of completion and demonstration of functionality/ specifications, clarity of presentation, oral examination, work knowledge and involvement
4	Report	15	the committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level(not more than 25%)
5	Supervisor/Guide	10	
	Total Marks	100	

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222LCE002	ADVANCED DESIGN STUDIO	LABORATORY	0	0	2	3

Preamble: This laboratory course intends to equip the students to get familiar with the use of advanced software that may be used to analyse and design various engineering structures related to foundation and superstructure and their interaction.

Course Outcomes: To make the students aware of application of softwares in analtsis and design of elements of soil mechanics, foundation engineering and structural engineering. .

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

CO 1	Visualize civil engineering problems using finite element software
CO 2	Model civil engineering problems using finite element software
CO 3	Analyse civil engineering problems using finite element software
CO 4	Solve the civil engineering problems using finite element software
CO 5	Appropriate software tools in applications of solutions to engineering to solve in-field challenges
CO 6	Judge the limitations and scope of numerical methods and arrive at proper design solutions

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	1	3	2	2	2
CO 2	2	2	1	2	2	2	2
CO 3	2	2	1	2	2	2	2
CO 4	2	2	1	3	2	2	2
CO 5	2	2	1	3	2	2	2
CO 6	2	2	2	3	2	2	2

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30%
Analyse	20%
Evaluate	50%
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: TEST I (All Cos) at the end of Semester and credit should be taken for Viva for each Lab session and total credit for Viva marks should be 20 which should be added to TEST I which will be assessed in 80 marks

Split up of 80 marks: (Procedure -10, Working-10, Tabulation (15), Calculations (25), Result (10), Viva (10)

Syllabus and Course Plan(For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

No	Topic	No. of practicals
1	**PLAXIS** 2D	
1.1	Analysis of a circular footing on sand using PLAXIS 2D	
1.2	Analysis of submerged construction of an excavation using PLAXIS 2D	
1.3	Analysis of dry excavation using a tie back wall using PLAXIS 2D	
1.4	Analysis of a road embankment using PLAXIS 2D	
2	**ANSYS**	
2.1	Analysis of Cantilever beam in ANSYS	
2.2	Analysis of continuous beam in ANSYS	
2.3	Analysis of truss in ANSYS	
2.4	Plane strain analysis in ANSYS	
3	**ETABs**	
3.1	Analysis of Cantilever beam	
3.2	Analysis of continuous beam	
3.3	Analysis of truss in ANSYS	
3.4	Analysis of Building Frame	

Reference Books

1.H. Lee, Finite Element Simulations with ANSYS Workbench 15, 1st Edition, USA, SDC publications,2014.

2.M. Thompson, ANSYS Workbench for Finite Element Analysis, 1st Edition, UK, Butterworth-Heinemann, 2017.

3.PLAXIS 2D Tutorial Manual - Bentley

4.ANSYS Theory Reference

SEMESTER II

PROGRAM ELECTIVE III

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE024	STRUCTURAL DESIGN OF FOUNDATIONS AND EARTH RETAINING STRUCTURES	PROGRAMME ELECTIVE 3	3	0	0	3

Preamble: To introduce students to the detailed design issues related to both deep and shallow foundations. Familiarize with the design of pile foundation, pilecaps, design of various types of special foundations such as foundations for steel towers, water tank andchimneys. To design various types of earth retainingstructures.

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

CO 1	Ensure design concepts of shallowfoundation
CO 2	The student will be efficient in selecting suitable type of pile for different soil stratum and in evaluation of group capacity byformulation
CO 3	The student will be able to design different types of special foundations
CO 4	The student will be able to design different types of earth retaining structures.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	2	2	2	2	
CO 2	3	2	2	2	2	2	
CO 3	3	2	2	2	2	2	
CO 4	3	2	2	2	2	2	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	50
Analyse	50
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such
questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
M.TECH DEGREE EXAMINATION, DECEMBER 2019

Structural Design of foundation and Earth-Retaining Structures

Time: 2.5 Hrs
Maximum Marks:60

Use of IS 456:2000 permitted Assume missing data suitably.

PART A
Answer ALL Questions

1. Differentiate between strap footings and strip footings.
2. Describe the situations where a combined piled raft foundation is preferred.
3. Explain the role of pile cap for load transfer.
4. Describe different types of retaining wall based on the structural behaviour
5. Explain the role of cofferdams as retaining structures

(5 x 5 = 25 marks)

PART B

6. Design an isolated unsymmetrical square footing for a column 500mmx500mm, transmitting a load of 600kN and a moment of 30kN/m. The safe bearing capacity of soil may be taken as 120 kN/Sq.mm. Use M20 concrete and Fe415 steel and draw the reinforcement details.
7. Design a combined footing for two columns 500mm x 500mm each, 5m apart carrying a load of 1600kN,available width restriction is 2.4m. The SBC of soil is 200kN/sq. m. Use M25 concrete and Fe415 steel.
8. The load from a circular water tank supported by six columns rests on a ring beam which in turn rests on an annular raft. Assuming the near diameter of the centres of column line is 8m and the total load from the tank is 30,000kN, design the ring beam
9. Design a raft foundation for the lay out of six columns arranged in two rows and three columns, all 4.5 m apart. The four outer columns are 300x 300 mm in size and carry a load of 500kN. Two inner columns are 400x400 in size and carry a load of 800kN. In addition to this, each column carries a moment of 160kNm due to a wind load on the length of the building. Take the bearing capacity of soil as 100kN/m2. Use M20 concrete and Fe 415 steel.
10. Design a pile cap for a system of 3 piles supporting a column 500mm square carrying a load of 600kN. Assume the diameter of pile as 400mm. Use M20 concrete and Fe 415 steel
11. Design a counterfort retaining wall to retain 4m earth above ground level. The top of the earth is considered as level. The density of earth is 15kN/sq.m. The angle of internal friction of soil is 30 degrees. The safe bearing capacity of soil is 200kN/sq.m and the oefficient of friction between soil and wall is 0.6.
12. For the design of the spillway of a dam with the lifetime of 100 years the accepted risk can be taken as 5%. The cofferdam with 5 years lifetime of this dam is designed for 25 years flood.

(5 x 7 = 35 marks)

Syllabus and Course Plan

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Introduction to Limit State Design of reinforced concrete in foundations	3
1.2	Soil pressure for structural design; structural design of spread footings	4
1.3	Isolated footings, combined footings, column pedestals, column footings, strap footings, strip footings under several column.	5
2	**Module 2**	
2.1	Structural design of mat foundations	3
2.2	Beam and slab rafts – combined piled raft foundations (CPRF) – circular and annular rafts	4
2.3	Analysis of flexible beams on elastic foundations.	3
3	**Module 3**	
3.1	Structural design of different types of piles – under reamed pile foundations – Design of pile cap – pile foundation	4
3.2	Structural design of well foundation	3
3.3	Special foundations.Design of foundation for steel towers – foundation to water tank and chimneys	3
4	**Module 4**	
4.1	Retaining Structures - Stability of walls	3
4.2	Design of cantilever and counter fort walls	4
4.3	Design of gravity walls	3
5	**Module 5**	
5.1	Design of Coffer dams – Braced coffer dams	4
5.2	Stability of bottom excavation	3
5.3	Anchorage – Walls and tierods.	3

Reference Books

1.P.C.Varghese, “Design of Reinforced Concrete Foundations”, PHI – LTD – New Delhi,1998

2.Kurien N.P., “Design of foundation systems – Principles and Practices” ,Narora Publishinghouse
– New Delhi (third edition),1992 33

3. Bowles J.E., “Foundation Analysis and Design” (4Ed.), Mc.Graw Hill, NY,1996
4. Shamsher prakash, Gopal Ranjan, & Swami Saran, “Analysis and design of foundations and retaining structures”, Sarita Prakashan, New Delhi ,1979

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE025	ROCK MECHANICS AND TUNNELLING	PROGRAMME ELECTIVE 3	3	0	0	3

Preamble: This course is oriented to make the students understand the concepts of Rock mechanics with importance given to the material fabric, strength and deformation. This course is ideal for the orientation of geotechnical engineering post-graduate students to understand, analyse and evaluate the behaviour of rock as a geomaterial.

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

CO 1	Explain formation, properties, classification and exploration of rocks
CO 2	Examine the effect of discontinuities in engineering properties of a rock
CO 3	Identify the rheological behaviour of rocks
CO 4	Identify the behaviour of rock masses around openings, underground excavations and subsidence
CO 5	Evaluate the bearing capacity of rocks
CO6	Assess problems associated with tunnelling

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	1	3	3	3	1	1
CO 2	3	1	3	3	3	1	1
CO 3	3	1	3	3	3	1	1
CO 4	3	1	3	3	3	1	1
CO 5	3	1	3	3	3	1	1
CO 6	3	1	3	3	3	1	1

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20
Analyse	35
Evaluate	30
Create	15

Mark distribution

Total Marks	CIE	ESE	ESE Duration

100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question Paper

APJ Abdul Kalam Technological University
M.Tech Degree Examination
Branch: Geotechnical and Geoenvironmental Energy
Specialisation:
Subject: 02 CE 6422 Rock Mechanics and Tunneling
Time: 2.5 Hrs Max. Marks: 60

PART A
(Answer All Questions)

1. Explain the significance of porosity while designing a structure supported on rock.
2. Describe various defects of rock-masses and its significance.
3. Discuss about Constant Elastic-Strain Energy theory and its applications
4. Discuss the importance of lining in tunnels passing through weathered rock-mass.
5. Explain the process of computing bearing capacity of foundations in intact rocks.
6. Describe the factors influencing the bearing capacity of foundation in rocks.
7. Discuss the requirements of a good ventilation system in tunnels?
8. Explain the various cross-sectional shape of tunnels with necessary sketches?

(5*3=15)

PART B
(Answer any 5 Questions)

9. Discuss the behavior of rocks under hydrostatic compression

OR

10. Explain the Classification of rocks.

11. Explain Griffith's theory of fracture initiation in rock mass

OR

12. Explain the effect of discontinuities on rock strength with relevant cases.

13. Discuss the plastic behavior of rock mass around tunnels.

OR

14. Describe lined circular tunnel in a hydrostatic stress field.

15. Explain the uniaxial compression test on Rock and the classification based on the strength.

OR

16. What are the different methods to determine the safe bearing pressure on intact rocks?

17. Discuss any two methods of tunneling in soft rocks.

OR

18. Explain how rock bolting is done and how it improves the stability ofrock slopes?

Subject Coverage and Course Plan		
No	**Topic**	**No. of Lectures**
	Module 1 (8hrs)	
	Introduction	
1.1	Introduction - objective - scope and problems of rock mechanics - formation ofrocks - physical properties - classification of rocks and rock masses - static elasticconstants of rock	2
1.2	Rock exploration rock coring - geophysical methods	3
1.3	Rheological behaviour - strength/ failure criterion	3
	Module 2 (8 hrs)	
	Discontinuities and Strength of Rocks	
2.1	Discontinuities in rock masses - discontinuity orientation - effect of discontinuitieson strength of rock	3
2.2	Strength behaviour - compression - tension and shear - stress - strain relationships	3
	Coulomb Mohr-Griffith theory of brittle strength and other strength criteria	2
	Module 3 (8 hrs)	
3	**Opening in Rocks**	
3.1	Openings in rock mass and stresses around openings	2
3.2	Pressure tunnels - development of plastic zone	2
3.3	Rock support needed to avoid plastic deformation.	2
3.4	Lined and unlined tunnels - underground excavation and subsidence – rockmechanics applications	2
	Module 4 (8 hrs)	
4	**Bearing Capacity of Rocks**	
4.1	Bearing capacity of homogeneous as well as discontinuous rocks	2

4.2	Support pressure and slip of the joint	2
4.3	Delineation of types of rock failure, Unsupported span of underground openings - pillars	2
4.4	Rock testing - laboratory and field tests	2
	Module 5 (8 hrs)	
5	**Rock Slopes and Tunneling**	
5.1	Rock slopes - rock bolting - plastic mechanics	2
5.2	Tunnels - shapes - usages - method of construction - problems associated with tunnels - tunnelling	3
5.3	Rock slopes - rock bolting - plastic mechanics	3

Reference Books

1. R.E. Goodman, Introduction to Rock Mechanics, 2nd Edition, USA, John Wiley & Sons, 1988, ISBN: 978-0-471-81200-5
2. B. P. Verma, Rock Mechanics for Engineers, 4th Edition, India, Khanna Publishers, 1998, ISBN: 13-978-9387394155
3. N. Sivakugan., S. K. Shukla and B.M. Das, Rock Mechanics: An Introduction, 1st Edition, USA, CRC Press, 2014, ISBN: 9780367866754
4. J. A. Hudson, and J. P. Harrison, Engineering Rock Mechanics: An Introduction to the Principles, 1st Edition, UK, Elsevier Science, 2000, ISBN: 0 08 04 19 12 7
5. P. R Sheorey, Empirical Rock failure criteria, 1st Edition, UK, CRC Press, 1997, ISBN: 9789054106715
6. I. Farmer, Engineering Behaviour of Rocks, 1st Edition, Netherlands, Springer, 2011, ISBN: 13-978- 0412139802
7. V. S. Vutukuri and R D Lama, Handbook on Mechanical Properties of Rocks: 004 (Rock & Soil Mechanics Series) Switzerland, Trans Tech Pubn, 1978, ISBN: 0-87849-021-3 C. Jaeger, Rock Mechanics and Engineering, 1st Edition, UK Cambridge University Press, 2009, ISBN: 978-0521103381

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE026	ADVANCED STEEL STRUCTURES	PROGRAMME ELECTIVE 3	3	0	0	3

Preamble: Review of loads on structures, Types of connections, Design of self supporting chimney, Theory ofplastic bending, Limit State Design and Behaviour of Compression Elements

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

CO 1	Classify the structures and wind load analysis for frames.
CO 2	Exposure to design of steel chimneys
CO 3	Analyse the beams and frames using plastic method
CO 4	Able to design different steel structures
CO 5	Analysis of steel compression members.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	2	2	2	2	-
CO 2	2	2	2	2	2	2	-
CO 3	2	2	2	2	2	2	-
CO 4	2	3	2	2	2	2	-
CO 5	2	2	2	2	2	2	-

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	35%
Analyse	15%
Evaluate	10%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed
Original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:
There will be two parts; Part A and Part B. Part A contain 5 numerical/short answer questions with one question from each module, having 5 marks for each question. Students should answer all questions. Part B contains 7 questions with minimum one question from each module of which student should answer any five. Each question carries 7 marks.

Model Question paper

APJ Abdul Kalam Technological University
M.Tech Degree Examination
Branch: Geo-technical and Geo-environmental Engineering
Course Code &Name :222ECE026 ADVANCED STEEL STRUCTURES
Time: 2.5 Hrs Max. Marks: 60

PART A
Answer All Questions
Each question carries 5 marks

1. What are the different types of beam column connections?
2. Mention the forces acting on the guyed steel stacks
3. Explain the method of plastic analysis
4. Explain the stability of a chimney is checked during the design process.
5. What are edge stiffeners? Write down the expression for minimum moment of inertia of edge stiffener?

PART B
Answer any 5 Questions

6. A building of height 20m and size 20mx60m is proposed to be built in a level ground at New Delhi where there are some existing tall buildings. Basic wind speed at this location is 44m/s. The building is to be designed for a return period of 50 years. Estimate the risk, topography, terrain coefficients and compute design wind speed and pressure on the building. (7marks)

7. Discuss in detail the merits, demerits and applications of welded connections. (7marks)

8. A factored axial compressive load of 1500kN and factored bending moment of 90kNm is acting on a column section ISHB 350 @ 661.2N/m. Design the base plate for the column. Assume concrete pedestal of grade M20. (7marks)

9. Define
   a. shape factor (2marks)

b. yield length (2marks)
c. lateral buckling of beam (3marks)

10. A beam fixed at both ends is subjected to a uniformly distributed load w on its right half portion. Identify the collapse load if the beam has uniform cross section. (7marks)

11. An ISLB 300 carrying a udl of 50kN/m has effective span of 8m.This is to be connected to the web of a girder ISMB 450. Design the framed connection using 20mm black bolts. (7marks)

12. Explain
    a. What is meant by limit state design? (3marks)
    b. What are special features of limit state design method? (4marks)

Syllabus

Module 1: Loads on structures and Connections (8 HOURS)

Dead, live, wind and seismic loads as per IS 800-2007 - Design of purlins, Louver rails, gable column and gable wind girder - Design requirement of bolted and welded connections - Unstiffened and Stiffened seated Connections. Moment Resistant Connections - Semi rigid Connections. Split beam Connections and Framed Connections

Module 2: Design of self supporting chimney (8 HOURS)

Design of base plates, foundations and anchor bolts- Guyed steel chimney, Guy ropes – stresses due to wind, Along with load calculation – gust factor method.

Module 3: Theory of plastic bending (8 HOURS)

Plastic hinge concept - Concept mechanism method - Application to continuous beam and portal frames - Plastic moment distribution

Module 4: Limit State Design –Ultimate and serviceability limit states (8 HOURS)

Limit state design of axially loaded members - Design of beams

Module 5: Behaviour of Compression Elements (8 HOURS)

Effective width for load and deflection determination - Behaviour of Unstiffened and Stiffened Elements - Design of web for beams - Flexural members - Lateral buckling of beams - Shear Lag, Flange Curling - Design of Compression Members - Wall Studs

Course Plan

No	Topic	No. of Lectures
1	**Loads on structures and Connections**	**(8 HOURS)**
1.1	Dead, live, wind andseismic loads as per IS 800-2007	1
1.2	Design of purlins, Louver rails, gable column and gable wind girder	2
1.3	Design requirement of bolted and welded connections	2
1.4	Unstiffened and Stiffened seated Connections	1
1.5	Moment Resistant Connections - Semi rigid Connections	1
1.6	Split beam Connections and Framed Connections	1
2	**Design of self supporting chimney**	**(8 HOURS)**
2.1	Design of base plates, foundations and anchor bolts	2
2.2	Guyed steel chimney	2
2.3	Guy ropes – stresses due to wind	2
2.4	Along with load calculation – gust factor method.	2
3	**Theory of plastic bending**	**(8 HOURS)**
3.1	Plastic hinge concept	2
3.2	Concept mechanism method	2
3.3	Application to continuous beam and portal frames	2
3.4	Plastic moment distribution	2
4	**Limit State Design –Ultimate and serviceability limit states**	**(8 HOURS)**
4.1	Limit state design of axially loaded members	4
4.2	Design of beams	4
5	**Behaviour of Compression Elements**	**(8 HOURS)**
5.1	Effective width for load and deflection determination	1
5.2	Behaviour of Unstiffened and Stiffened Elements	1
5.3	Design of web for beams	2
5.4	Flexural members	1
5.5	Lateral buckling of beams - Shear Lag, Flange Curling	1
5.6	Design of Compression Members	1
5.7	Wall Studs	1

Reference Books

1.Subramanian.N, “Design of Steel Structures”, Oxford University Press, 2008.

2.Dayaratnam.P, “Design of Steel Structures”, A.H.Wheeler, India, 2007.

3. S.S Bhavikatti“ Design of steel structures” I.K International Publishing house Pvt Ltd

4. S.K Duggal “ Limit State Design of steel structures’ TMH publications

5. IS 800 General Construction in Steel — Code of Practice

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE027	CONSTITUTIVE MODELING AND FEM	PROGRAMME ELECTIVE 3	3	0	0	3

Preamble: This course aims to equip the students with the Finite Element Analysisfundamentals,formulate the design problems into FEA,to the use of FEM in soil and rockmechanicsand to perform engineering simulations using Finite Element Analysis software(ANSYS).

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

CO 1	understandFinite Element Analysisfundamentals.
CO 2	develop finite element formulations of 1 degree of freedom problems and solve them.
CO 3	analyse framed structures andplates.
CO 4	apply FEA in soil and rockmechanics.
CO 5	Understand finite element programming and perform engineering simulations using Finite Element Analysis softwares

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	2	2	2	2	
CO 2	3	2	2	2	2	2	
CO 3	3	2	2	2	2	2	
CO 4	3	2	2	2	2	2	
CO 5	3	2	2	2	2	2	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30%
Analyse	30%
Evaluate	30%
Create	10%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed
Original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Model Question Paper

APJ Abdul Kalam Technological University
M.Tech Degree Examination
Branch: Geomechanics and Structures
Course Code :221TCE027
Course Name:CONSTITUTIVE MODELING AND FEM

Time: 2.5 Hrs Max. Marks: 60

PART A
Answer All Questions
Each question carries 5 marks

1. State and explain the principle of virtual displacement.
2. Discuss the characteristics of shape functions.
3. Explain the reason for the need of the transformation matrix in the truss analysis using FEM
4. Discuss reduced integration in FEM
5. Explain the locking problem in finite element analysis of plates.

PART B

Answer any 5 Questions

6.Discuss different plate theories and its suitability of applications. (7marks)

7.Discuss structural idealization and discretization of the structure using FEM (7marks)

8. Derive the shape function for a three noded bar element with one d.o.f /node using generalized coordinates. (7marks)

9.Explain Rayleigh Ritz method with the help of simple beam bending problem. (7marks)

10. A rod of 300 mm length fixed at left end and free at the right end is subjected to an axial tensile force of 600kN at the midpoint. Determine displacement at each node and stresses in each element if the movement of the right end is restricted to 1.2mm. Use two elements for discretisation. Take A=200mm2 and E= 200000MPa. (7marks)

11.Obtain an isoparametric finite element formulation for a four noded quadrilateral
plane stress element. (7marks)

12.Discuss the use of FEM in soil and rock mechanics. (7marks)

Syllabus and Course Plan

No	Topic	No. of Lectures
1	**Module 1(8 hours)**	
1.1	Basic Equations of Solid Mechanics- Review of equilibrium conditions,	1
1.2	Strain-displacement relations, Stress - Strain relations,	1
1.3	Principle of Virtual work & Stationery potential energy	1
1.4	Plane stress and plane Strain problems.	1
1.5	Basics of finite element method (FEM). Discretisation: continuum – node – element – degrees of freedom – general principles for discretization of geotechnical problems – discretization of very large bodies – discretization of infinite bodies – mesh refinement.	2
1.6	Different steps involved in FEM.	1
2	**Module 2 (10 hours)**	
2.1	Different approaches of FEM- Direct method, Energy approach, Weighted residual Method	1
2.2	relation between nodal degrees of freedom and displacements at nodes Coordinate systems: global – local – natural (area) coordinates and rst coordinates	1
2.3	Displacement model - Shape functions -Lagrangian elements – serendipity elements-Hermitian elements – isoparametric elements (concept only; derivation not needed)Element properties. Shape functions in terms of global coordinates: 1D 2noded and 3noded bar elements; Shape functions in terms of area coordinates:1D element – 2noded beam element – 2D elements - 3 noded triangular	4

	element Shape functions for Lagrangian elements: 1D element –4 noded bar element – 2D elements – 4 noded rectangular element – Isoparametric element formulation: 1D element – 3 noded bar element – 2D elements – 4noded quadrilateral element – 8 noded quadrilateral element (home assignment) – 3 noded triangular element (home assignment)	
2.4	Equation for element stiffness matrix and nodal load vector using variational principle: derivation using principle of minimum potential energy;	1
2.5	Formulation of element stiffness matrix: 1D element - 2 noded bar element – constant CSA and varying CSA lying parallel to X axis – rotation transformation method - 2 noded inclined truss element with 2 dof at each node; Formulation of element stiffness matrix and nodal load vector: 2D element - 3 noded triangular element in terms of area coordinates – 4 noded quadrilateral element using isoparametric formulation;isoparametric elements:convergence criteria	3
3	**Module 3(9 hours)**	
3.1	Finite Element modeling of one and two dimensional problems.	2
3.2	Analysis of framed Structures-2D and 3D truss and beam elements and applications.	2
3.3	shear deformation in beams and beams on elastic foundation	1
3.4	Analysis of plane stress/strain and axisymmetric solids	2
3.6	isoparametricelements:convergence criteria	2
4	**Module 4(8 hours)**	
4.1	Loading - Non-uniform material properties- Constitutive laws-Elastic-plastic behaviour-Tension in soils and rocks-	2
4.2	Numerical integration, order of integration-evaluation of stiffness matrix using numerical integration techniques,	1
4.3	Analysis of plate bending. Basic equations of thin plate theory.	2
4.4	Reissner-Mindlin theory - Plate elements and applications.	2
4.5	Analysis of shells -degenerated shell elements.	1
5	**Module 5 (5 hours)**	
5.1	Use of FEM in soil and rock mechanics -	3
5.2	Finite element programming and FEA Software	2

Text books

1. Desai, C.S and Abel J.F, “Introduction to Finite Element Method”, CBS Publishers and Distributors, Delhi.1987

2. Cook R. D. “Concepts and Applications of Finite Element Analysis”, John

Wiley, New York, 2004.

3. Zienkiewicz O. C. and Taylor R. L., "Finite Element Method, Butterworth Heinemann publication",2000.

4. Smith I.M , "Programming the FEM with applications to Geomechanics", John Wiley&Sons ,1982

Reference Books

1. Reddy J. N., " An introduction to Linear Finite Element Method, Oxford University Press", Oxford,2004.

2. Chandupatla T. R. &Belegundu A. D, "Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 5th Reprint,1999

3. Krishnamoorty C.S. "Finite element methods", Tata-Mc Graw Hill, Second Edition, Delhi,2002.

4.Gudehus.G, "Finite Elements in Geomechanics", John Wiley & Sons , 1977

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE028	PROBLEMATIC SOILS AND GEO ENVIRONMENTAL CONCERNS	PROGRAMME ELECTIVE 3	3	0	0	3

Preamble: To impart in-depth knowledge on the challenges of different problematic soils and to understand their characteristics. To comprehend the effects of environmental interaction with problematic soils and to explore on the treatment and remediation of problematic soils .

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

CO 1	To understand the problems associated with problematic soils
CO 2	To evaluate the characteristics of different problematic soils
CO 3	To comprehend the effects of contamination and climate change on the problematic soils
CO 4	To select the appropriate treatment and remediation techniques for different types of problematic soils
CO 5	To assess the application of various treatments in terms of case studies for improving problematic soils

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	3	2	3	
CO 2	3	2	3	3	2	3	
CO 3	3	2	3	3	2	3	
CO 4	3	2	3	3	2	3	
CO 5	3	2	3	3	2	3	
CO 6	3	2	3	3	2	3	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70
Analyse	
Evaluate	30
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such
questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question paper

APJ Abdul Kalam Technological University

M.Tech Degree Examination
Branch: Geotechnical and Geoenvironmental Energy
Subject: Problematic soils and Geo Environmental concerns
Time: 2.5 Hrs Max. Marks: 60
PART A
(Answer All Questions)

1. Give a description on the distribution of problematic soils in India

2. Explain the characterization of collapsible soils and black cotton soils

3. Comment on the effect of acids and alkali on volume change in expansive soils

4. What are the various improvement methods for an organic soil?

5. Explain the risks, challenges and solutions for construction in desert soils

(5 x 5 = 25 marks)

PART B
(Answer any 5 Questions)

6. Explain the major challenges associated with marine clays and reclaimed soils

7. Explain on the physcio chemical characteristics of peat soils

8. Discuss effect of climate change on movements in expansive soils

9. Describe the various methods for improving collapsible soils

10. What are the criteria for choosing soil improvement methods in problematic soils

11. Comment on the sustainability and risk in improving expansive soil with cement stabilisation

12. Discuss a case study for construction in any problematic soil

(5 x 7 = 35 marks)

Syllabus and Course Plan

No	Topic	No. of Lectures
1	**Module 1: Problematic soils**	
1.1	Types of problematic soils	2
1.2	Clasifcation	2
1.3	Relative distribution globally and in India	2
1.4	Major challenges faced with problematic soils	2
2	**Module 2: Characteristics ofProblematic soils**	
2.1	Characteristics of expansive soil	2
2.2	Characteristics of marine soils,	1
2.3	Characteristics organic soilsand peat	1
2.4	Characteristics dispersive/collapsible soils	1
2.5	Charcterstics of desert soil	1
2.6	Characteristics of reclaimed soils	1
3	**Module 3: Soil-environment interaction with problematic soils**	
3.1	Effect of contaminants	4
3.2	Climate change effects on problematic soils	3
4	**Module 4: Soil improvement and Remediation measures**	
4.1	Improvement of problematic soils by mechanical methods	3
4.2	Improvement for for problematic soils using chemical methods	3
4.3	Improvement for for problematic soils by non conventional methods	2
5	**Module 5: Risk assessment and approaches for sustainability in problematic soils**	
5.1	Risk and hazard asocated with problematic soils	2
5.2	Case studies on construction in problematic soils	3
5.3	Sustainabily assessment in improving probklematic soils	2

Reference Books

1. John D Nelson and Debora J Miller., “Expansive Soils – Problems and Practice in Foundation and Pavement Engineering”, John Wiley & Sons, INC. 1992

2. RamachandraPhanikumar and Sana Suri., “Expansive Soils – Problems and Remedies”, LAP Lambert Academic Publishing 2013

3. D.R. Katti, AR Katti, Behavior of Saturated Expansive Soils and Control methods, Taylor and Francis 2002

5. GopalRanjan and AS Rao, Basic and Applied Soil Mechanics, New Age International Publishers, New Delhi 2016

6. Foundation in Expansive Soils, Technical Manual, US Army Corps of Engineers, Washington DC. 1993

7. F.H.Chen, Foundations on Expansive Soils, Elsevier Scientific Publishing Company, New York 1988

8.H. G. Poulos. “Marine Geotechnics”, Unwin Hyman Ltd, London, UK, 1988

9.D. F. McCarthy, “Essential of Soil Mechanics and Foundations,” Prenticle Hall, Upper Saddle River, 2006.

10. F. G. Bell, “Engineering Properties of Soils and Rocks,” Blackwell Science, Oxford, 2000

11. B. M. Das, “Principles of Geotechnical Engineering,” Thomson, New York, 2009.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE029	BEHAVIOUR AND TESTING OF UNSATURATED SOILS	PROGRAMME ELECTIVE 3	3	0	0	3

Preamble: To impart knowledge of unsaturated soil behaviour and the manner in which practical unsaturated soil engineering problems are solved. The students will be equipped to deal the research works on unsaturated soils.

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

CO 1	To define the fundamental properties of unsaturated soils
CO 2	To assess the suction in unsaturated soils
CO 3	To understand the thermodynamic equilibrium of unsaturated soil
CO 4	To evaluate the shear strength of unsaturated soils
CO 5	To evaluate the compression characteristics of unsaturated soils

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	3	3	3	
CO 2	3	3	3	3	3	3	
CO 3	3	3	3	3	3	3	
CO 4	3	3	3	3	3	3	
CO 5	3	3	3	3	3	3	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%
Analyse	30%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such
questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question Paper

APJ Abdul Kalam Technological University

M.Tech Degree Examination

Branch: Geotechnical and Geoenvironmental Energy

Specialisation: Transportation Engineering

Subject: 0BEHAVIOUR AND TESTING OF UNSATURATED SOILS

Time: 2.5 Hrs Max. Marks: 60

PART A

(Answer All Questions)

1. Explain the need and application areas for unsaturated soil mechanics

2. Explain the role of osmotic suction

3. Comment on the heat capacity and specific heat for unsaturated soils

4. Explain the extended Mohr-Coulomb failure envelope.

5. Comment on the compressibility of air-water mixtures. (5 x 5 = 25 marks)

PART B

(Answer any 5 Questions)

6. Describe contractile skin with its distinctive features.

7. Explain the types of tensiometers used for suction measurement

8. Explain the measurement of soil water characteristic curves using pressure plate devices.

9. How is the unfrozen water content measured for unsaturated soils?

10. Explain the methods for calculating shear strength of unsaturated soils.

11. How is air volume change measured for unsaturated soils?

12. Explain Hilf's analysis for computing change in pore pressure. (5 x 7 = 35 marks)

Syllabus and Course Plan

No	Topic	No. of Lectures
1	**Fundamental properties of unsaturated soils**	
1.1	Properties of unsaturated soils, Nature and genesis of unsaturated soils	2
1.2	Soil variables, Particle properties	2
1.3	Phase properties and interactions, Soil structure, Pore size determination	2
1.4	Experimental technique for determination pore size distribution	2
2	**Suction in unsaturated soils**	
2.1	Matric suction and osmotic suction , Suction Measurement and Control Techniques for measurement of suction, (Laboratory tests)	3
2.2	Effective stress concepts- Effective stress relations in unsaturated soil	2
2.3	Collapse and heave characteristics of unsaturated soil	2
2.4	Flow through unsaturated soils	2
3	**Thermodynamic equilibrium of unsaturated soils**	
3.1	Enthalpy and Equilibrium, Stress conditions in unsaturated Soil, Role of enthalpy	3
3.2	Terzhagi's effective stress for saturated soils Enthalpy for unsaturated soils	2
3.3	Signification of α Stress state in unsaturated soils, Graphical representation of stress	2
4	**Shear strength of unsaturated soils**	
4.1	Shear strength of unsaturated soils	2
4.2	Soil-strength characteristics of unsaturated soil	2
4.3	Equivalent strength parameters	2
4.4	Pre-yield behaviour - Yield limit	2
5	**Compression Characteristics of unsaturated soils**	
5.1	Osmotic oedometer tests on reconstituted soil	2
5.2	Water retention characteristics	2
5.3	Compression characteristics of unsaturated Kaolin	2

5.4	Modelling of unsaturated Kaolin	2

Reference Books

1. Fredlund, D.G and Rahardjo,R Soil Mechanics for unsaturated soils, Wiley, New York, 1993.

2. Murray E J and Sivakumar V, Unsaturated Soils: A Fundamental Interpretation of Soil Behaviour, wiley, New York, 2010.

3. Tarantino, A. and Jommi, C. Hydraulic and mechanical behaviour of unsaturated soils: Experimental evidence and constitutive modeling, 2005.

4. Mitchell, J. K. and Soga, K., Fundamentals of soil behavior. John Wiley & Sons, Inc., New Jersey, third edition, 2005

SEMESTER II

PROGRAM ELECTIVE IV

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE030	REPAIR AND REHABILITATION OF STRUCTURES	PROGRAMME ELECTIVE 4	3	0	0	3

Preamble: To identify various deterioration mechanisms or damage mechanisms in concrete structures. Both the scientific aspects and its use while practicing repair works at site. Uses of various non-destructive, partially-destructive tools to assess the conditionof the structures.

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

CO 1	Understand the fundamentals of maintenance and repair strategies
CO 2	Identify for serviceability and durability aspects of concrete
CO 3	Know the materials and techniques used for repair of structures
CO 4	Decide the appropriate repair and retrofitting techniques
CO 5	Use appropriate health monitoring technique and demolition methods

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	1	-	-	-	-
CO 2	2	2	1	-	-	-	-
CO 3	3	2	1	-	-	-	-
CO 4	2	2	1	-	-	-	-
CO 5	2	2	1	-	-	-	-

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	45%
Understand	35%
Apply	10%
Analyse	10%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	: 15 marks
Course based task/Seminar/Data collection and interpretation	: 15 marks
Test paper, 1 no.	: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 5 numerical/short answer questions with one question from each module, having 5 marks for each question. Students should answer all questions. Part B contains 7 questions with minimum one question from each module of which student should answer any five. Each question carries 7 marks.

Model Question Paper

APJ Abdul Kalam Technological University
M.Tech Degree Examination
Branch: Geo-technical and Geo-environmental Engineering
Course Code &Name : 222ECE030
REPAIR AND REHABILITATION OF STRUCTURES

Time: 2.5 Hrs Max. Marks: 60

PART A
Answer All Questions
Each question carries 5 marks

1. Define Maintenance. What are the facets of maintenance?
2. Define the term "Quality assurance" in concrete structures & importance of quality control
3. Define polymer concrete and its various types.
4. List the methods to overcome low member strength in concrete structures and State the need of accelerated strength
5. In what cases demolition by machine can be done and Illustrate the term dilapidated structures.

PART B
Answer any 5 Questions

6. Describe the various repair strategies for RC buildings. (7marks)
7. Write down the types of inspection carried out for concrete structure. (7marks)
8. Explain in detail the effects on durability and strength of concrete due to Climate (7marks)
9. Explain the behavior of steel fibre reinforced concrete as a repair material. (7marks)
10. State the purpose of underpinning and explain its method. (7marks)
11. State and explain the various options for strengthening a concrete with low member strength (7marks)
12. Discuss a case study on engineered demolition technique. (7marks)

Syllabus

Module 1: Maintenance & Repair Strategies (8 Hours)

Repair and rehabilitation- facts and importance of maintenance - Various aspects of inspection - Assessment procedure for evaluating damaged structure - Causes of deterioration & distress in concrete structures - Construction and design failures - Condition assessment and distress - Diagnostic techniques - Assessment procedure for inspection and evaluating a damaged structure

Module 2: Serviceability and Durability of Concrete (8 Hours)

Quality assurance for concrete construction - Concrete properties-strength, permeability, thermal properties and cracking - Effects due to climate, temperature, chemicals, corrosion

Module 3: Materials and Techniques for Repair (8 Hours)

Special concretes and mortar, concrete chemicals - Special elements for accelerated strength gain - Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete, bacterial concrete, rust eliminators - Polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete - Gunite and shotcrete, epoxy injection, mortar repair for cracks - Shoring and underpinning

Module 4: Rehabilitation, Retrofitting & Strengthening Techniques (8 Hours)

Repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure - Common types of repairs - Repair in concrete structures - Repairs in under water structures - Strengthening Methods, retrofitting, jacketing

Module 5: Health Monitoring and Demolition Techniques (8 Hours)

Long term health monitoring techniques - Engineered demolition techniques for dilapidated structures - Use of sensors for building - Instrumentation

Course Plan

No	Topic	No. of Lectures
1	**Maintenance & Repair Strategies**	**(8 Hours)**
1.1	Repair and rehabilitation- facts and importance of maintenance	1
1.2	Various aspects of inspection	1
1.3	Assessment procedure for evaluating damaged structure	1
1.4	Causes of deterioration & distress in concrete structures	1
1.5	Construction and design failures	1
1.6	Condition assessment and distress	1
1.7	Diagnostic techniques	1
1.8	Assessment procedure for inspection and evaluating a damaged structure.	1
2	**Serviceability and Durability of Concrete**	**(8 Hours)**
2.1	Quality assurance for concrete construction	2
2.2	Concrete properties-strength, permeability, thermal properties and cracking	3
2.3	Effects due to climate, temperature, chemicals, corrosion	3
3	**Materials and Techniques for Repair**	**(8 Hours)**
3.1	Special concretes and mortar, concrete chemicals	1
3.2	Special elements for accelerated strength gain	1
3.3	Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete, bacterial concrete, rust eliminators	2
3.4	Polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete	2
3.5	Gunite and shotcrete, epoxy injection, mortar repair for cracks	1
3.6	Shoring and underpinning	1
4	**Rehabilitation,Retrofitting & Strengthening Techniques**	**(8 Hours)**
4.1	Repairs to overcome low memberstrength, deflection, cracking, chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure	3
4.2	Common types of repairs	1
4.3	Repair in concrete structures	1
4.4	Repairs in underwater structures	1
4.5	Strengthening Methods, retrofitting, jacketing	2
5	**Health Monitoring and Demolition Techniques**	**(8 Hours)**
5.1	Long term health monitoring techniques	2
5.2	Engineered demolition techniques for dilapidated structures	2
5.3	Use of sensors for building	2
5.4	Instrumentation	2

Reference Books

1. Concrete Technology by A.R. Santakumar, Oxford University press
2. Concrete Technology – Theory and Practiceby M.S.Shetty, S.Chand and Company, New Delhi, 1992
3. Repair and Rehabilitation of Concrete Structures by Vidivelli.B Standard Publishes Distribution.1st edition 2009.
4. Maintenance, Repair & Rehabilitation and Minor Works of Buildings by P. C. Varghese, PHI.
5. Defects and Deterioration in Buildingts, E F & N Spon, London
6. Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE031	APPLICATION OF REMOTE SENSING IN GEOTECHNICAL ENGINEERING	PROGRAMME ELECTIVE 4	3	0	0	3

Preamble: To impart in-depth knowledge of the modern skills and tools related to Environmental Geotechnical engineering so as to enable them to address the environmental aspects and sustainable issues related to infrastructure development of the country.

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

CO 1	To understand the components of remote sensing systems for data acquisition
CO 2	To categorise various remote sensing platforms for data production
CO 3	To examine the data to derive meaningful inferences for decision making
CO 4	To understand GPS and GIS for selected practical situations
CO 5	To apply tools and techniques of remote sensing for various Geotechnical applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	3	2	3	
CO 2	3	2	3	3	2	3	
CO 3	3	2	3	3	2	3	
CO 4	3	2	3	3	2	3	
CO 5	3	2	3	3	2	3	
CO 6	3	2	3	3	2	3	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70 %
Analyse	30 %
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such
questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question Paper

APJ Abdul Kalam Technological University
M.Tech Degree Examination
Subject: SUSTAINABLE GEOTECHNICS
Time: 2.5 Hrs Max. Marks: 60

PART A
(Answer All Questions)

1. Compare active and passive remote sensing.

2. Describe the Spectral and spatial resolution of various remote sensors

3. Illustrate the Characteristics of photographic images

4.Discuss the Advantages of GPS and GIS in the storage thematic information extracted from remotely sensed images.

5. Explain in Role of remote sensing and GIS in terrain investigation. (5x5=25)

PART B
(Answer any 5 Questions)

6.Explain the components of remote sensing system.

7.Discuss radio wave remote sensing. Compare Linear Imaging Self Scanner (LISS)and thermal infrared scanning systems

8. Discuss the spectral signature with reference to soil, water and vegetation.

9. Explain the significance geo-referencing of imagery

10. Explain the GPS observation methods and their advantages over conventional methods

11. Discuss the significance of Geological mapping for the geotechnical investigations of soil strata.

12. Explain the techniques involved in monitoring of areas prone to landslides using remote sensing(5 x 7 = 35 marks)

Syllabus and Course Plan

No	Topic	No. of Lectures
Module I (7 hours)		
1.1	Definitions and introduction to remote sensing	1
1.2	Components of remote sensing system, active and passive remote sensing	1
1.3	electromagnetic radiations and their interactions with the earth features and atmosphere	1
1.4	Spectral windows and spectral signatures and their significance in remote sensing.	1
1.5	Radiometric quantities used in the collection of spectral signatures.	1
1.6	Remote sensing satellite orbits	1
1.7	Image acquisition process, repeativity, row/path and ground swath and coverage.	1
Module II (8 hours)		
2.1	Various remote sensing platforms like ground based, air borne and satellite based	1
2.2	Passive and active remote sensors: Return Beam Videocon (RBV)	1
2.3	Multi-Spectral Scanners (MSS), Thematic Mapper (TM),	1
2.4	Linear Imaging Self Scanner (LISS), thermal infrared scanning systems, radiometers, Radar, Lidar and SAR	1
2.5	Spectral and spatial resolution of various remote sensors with special relevance to Indian Remote Sensing satellites	1
2.6	Push broom scanners	1
2.7	Radiometers, Radar, Lidar and SAR	1
2.8	Different types of remotely sensed data products	1
Module III (8 hours)		
3.1	Geometry, radiometry and pre-processing of remotely sensed imagery	1
3.2	Ground truth collection and geo-referencing of imagery	1
3.3	Characteristics of photographic images	1
3.4	Colour, tone and texture,	1
3.5	Techniques of photo-interpretation	1
3.6	Digital image classification techniques	1
3.7	Extraction of thematic information	1
3.8	Photo-interpretation keys	1
Module IV (8 hours)		
4.1	Global Positioning System (GPS) : Introduction & components of GPS, Space segment, control segment and user segment	1
4.2	Elements of Satellite based Surveys – Map datums, GPS	1

	receivers, GPS observation methods and their advantages over conventional methods	
4.3	Geographic Information System (GIS)- Definition of GIS, Geographical concepts and terminology	1
4.4	Components of GIS	1
4.5	Raster and vector formats	1
4.6	Scanners and digitizers	1
4.7	Data acquisition	1
4.8	Advantages of GPS and GIS in the storage thematic information extracted from remotely sensed images	
Module V (9 hours)		
5.1	Role of remote sensing and GIS in terrain investigation and advantages over conventional mapping techniques	1
5.2	Extraction of topographic information from remotely sensed data and generation of digital terrain model from stereo pairs of images.	1
5.3	Resource mapping for engineering project	1
5.4	Selection of sites for construction materials, water resources, soil, buildings, railways and highways	1
5.5	Geological mapping for the geotechnical investigations of soil strata	2
5.6	Digital Model	1
5.7	Application of visible, infra-red and microwave remote sensing for the identification of soil types, grain size and moisture studies.	2

Reference Books

1. Lo, C.P. & Yeung A.K.W., Concepts and Techniques of Geographic Information

Systems,Prentice Hall of India, New Delhi, 2006.

2. Anji Reddy, M., Remote Sensing and Geographical Information Systems, B.S.Publications, Hyderabad, 2001.

3. Geo Information Systems – Applications of GIS and Related Spatial Information

Technologies,ASTER Publication Co., Chestern (England), 1992

4. Marble, D.F., Galkhs HW &Pequest, Basic Readings in Geographic Information Systems, SpedSystem Ltd., New York, 1984.

5. Kennie, T. J. M. and Matthews M. C., Remote Sensing in Civil Engineering, Surrey

University Press, Glasgow 1985

6. Lillesand T.M. and Kiefer R. W., Remote Sensing and image interpretation, John Wiley and Sons. New York , 2015

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE032	SOIL STRUCTURE INTERACTION	PROGRAMME ELECTIVE 4	3	0	0	3

Preamble: This course willImpart knowledge in the theory of soil-structure interaction, Develop the ability for elastic analysis of pile, Impart skill for developing theoretical solutions for settlement and load distributions and Inculcate skill for analyzing pile raft system

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

CO 1	Describe soil-structure interaction and soil response models
CO 2	Analyze beams on elastic foundation
CO 3	Analyze plates resting on elastic medium
CO 4	Analyze piles and pile groups elastica
CO 5	Determine lateral capacity of the pile using sub-grade reaction and elastic analysis
CO6	Analyze pile-raft system using influence charts

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	3	3	1	1
CO 2	2	3	3	2	3	1	1
CO 3	3	2	3	3	3	1	1
CO 4	3	3	2	2	3	1	1
CO 5	3	3	3	3	3	1	1
CO 6	3	3	3	2	3	1	1

Assessment Pattern

Bloom's Category	End Semester Examination(%)
Apply	20
Analyse	35
Evaluate	30
Create	15

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question Paper

APJ Abdul Kalam Technological University
M.Tech Degree Examination
Branch: Geotechnical and Geoenvironmental Energy
Specialisation:
Subject: 02 CE 6422 Soil Structure Interaction
Time: 2.5 Hrs Max. Marks: 60

PART A
(Answer All Questions)

1. What are interface stresses between foundation and soil?
2. A circular plate resting on springs are subjected to uniformly distributed load "W" in the entire area of the plate. End of the plates are free. Find BM and SF at the edge of the plate.
3. In which type of soil critical depth is significant? Why?
4. Explain about pile spacing in a pile group.
5. Differentiate between short piles and long piles.

(5*3=15)

PART B
(Answer any 5 Questions)

6.Explain contact pressure distribution under a rigid footing in sand and clay. Also discuss about the settlements in each case.

OR

7. What are the factors affecting the magnitude of the coefficient of subgrade reaction?.

8.Find bending moment and shear force acting on a combined footing resting on sand. Length of footing 7m. Width of footing 1.2m. A column load of 660kN and 280kN are acting at 2.2m and 6.5m from LHS of the footing. Modulus of subgrade reaction can be taken as 30000kN/m3.

OR

9. Explain how anlaysis of railwat track can be carried out using 'beams on elasatic foundation' concept, bringing out assumptions involved.

10.A mat slab is resting on soil having effective modulus of sub grade reaction of 50000kN/m3. The mat slab supporting 9 columns (size 400 mm x 400 mm) symmetrically spaced at 4.0 m c/c without side projection of 0.3 m. Thickness of slab 500 mm. Corner column loads = 500kN, other outer column loads = 700kN and inside column loads = 1300kN. Concrete used M25. Find deflection at the centre of the mat slab.

OR

11.Explain the analysis of mat foundation using any one of the flexible methods. Bring out the assumptions involved.

12.A pile of 15 m length with diameter of 0.5 m is installed into a layered clayey soil. Clayey bed has 3 layers.

a. Top layer 5.0 m thick cu = 30kPa, = 0.8
b) Middle layer 5.0 m thick cu = 45kPa, = 0.7
c) Below 10 m cu = 120kPa, = 0.4

Estimate safe bearing capacity of pile for a factor of safety of 3.0

OR

13. A group of 16 piles with 4 piles in a group is driven into a soft clay layer of greater depth. Diameter of pile is 0.4m and depth of pile is 15 .0m. Piles are spaced at 1.2m centre to centre. Unconfined compressive strength of clay is 60kPa. Estimate allowable load on the pile group for a factor of safety of 2.5.

14.Determine the lateral deformation at the top of the pile (at ground level) subjected to a lateral load of 90kN at ground level. Pile has a diameter of 0.7m and length of 20.0 m. Concrete used is M25. Horizontal subgrade modulus for the whole depth can be taken as 70000kN/m3. Pile top may be taken as free headed.

OR

15.What is a pile raft system? Explain about the interaction of piles and raft.

Subject Coverage and Course Plan		
No	**Topic**	**No. of Lectures**
	Module 1 (8hrs)	
	Introduction	
1.1	Soil-foundation interaction - introduction to soil-foundation interaction problems soil behaviour	1
1.2	Foundation behaviour	2
1.3	Interface behaviour - scope of soil foundation interaction analysis	2
1.4	Soil response models - Winkler - elastic continuum - two parameter elastic models	2
1.5	Elastic plastic behaviour - time dependent behaviour	2
	Module 2 (8 hrs)	
	Beams on Elastic Foundation	
2.1	Beam on elastic foundation	1
2.2	Soil models - infinite beam - two parameters	2
2.3	Isotropic elastic half space - analysis of beams of finite length	2
2.4	Classification of finite beams in relation to their stiffness	2
	Module 3 (7 hrs)	

3	**Plates on Elastic Medium**	
3.1	Plate on elastic medium - thin and thick plates - analysis of finite plates	4
3.2	Numerical analysis of finite plates - simple solutions	3
	Module 4(7 hrs)	
4	**Elastic Analysis of Piles and Pile groups**	
4.1	Elastic analysis of pile - elastic analysis of single pile	1
4.2	Theoretical solutions for settlement and load distributions	2
4.3	Analysis of pile group - interaction analysis	2
4.4	Load distribution in groups with rigid cap	2
	Module 5(8 hrs)	
5	**Laterally Loaded Pile and Pile Raft System**	2
5.1	Laterally loaded Pile - load deflection prediction for laterally loaded piles	2
5.2	Subgrade reaction and elastic analysis - interaction analysis	2
5.3	Pile raft system - solutions through influence charts	2

Reference Books

1. N. P. Kurien., Design of Foundation Sytems, Principles & Practices, 3rd Edition, New Delhi, Narosa,1992, ISBN: 13- 9788173194962.
2. L. C. Reese and W. F. Van Impe, Single pile and pile groups under lateral loading, 2nd Edition, The Netherlands, CRC press, Taylor & Francis, 2011, ISBN: 978-0-415-46988-3.
3. E. S. Melerski, Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation, 2nd Edition, United States, CRC press, Taylor & Francis, 2006, ISBN: 9780415383509.
4. G. Jones, Analysis of Beams on Elastic foundation, London, UK, Thomas Telford Publishing, 1997, ISBN: 13- 978-0727725752.
5. A. S. Cakmak, Soil Structure Interaction, 1st Edition, Netherlands, Elsevier Science Ltd, 1987, ISBN:9780444989574

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE033	SOIL DYNAMICS AND MACHINE FOUNDATION	PROGRAMME ELECTIVE 4	3	0	0	3

Preamble: To impart knowledge on Soil dynamics, and methods for determining dynamic soil properties and to apply this knowledge for the analysis and design of Foundation for Reciprocating machines and impact type machine. This course also helps the students to get knowledge on various methods of vibration isolation and also understand the phenomena of liquefaction of soil, when it is subjected to vibratory forces.

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

CO 1	explain fundamental concepts of soil dynamics and theory of vibration.
CO 2	evaluate dynamic soil properties of soil
CO 3	determine dynamic earth pressure acting on retaining walls and also to determine dynamic bearing capacity of shallow foundations
CO 4	design of machine foundation.
CO 5	describe vibration isolation and apply principles of vibration isolation for machinefoundations
CO 6	describe soil liquefaction and tests to evaluate liquefaction potential of soil

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	1	3	3	3	1	1
CO 2	2	1	3	3	3	1	1
CO 3	2	1	2	2	3	1	1
CO 4	2	2	2	2	3	2	1
CO 5	2	2	3	3	3	1	1
CO 6	2	2	2	3	3	1	1

Assessment Pattern

Bloom's Category	End Semester Examination (%)
Apply	30
Analyse	25
Evaluate	30
Create	15

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question Paper

APJ Abdul Kalam Technological University
Second Semester M.Tech Degree Examination
Branch: Civil Engineering
Specialisation: Geotechnical Engineering

Subject: SOIL DYNAMICS AN MACHINE FOUNDATION
Time: 2.5 Hrs Max. Marks: 60

PART A
(Answer All Questions)

1. Write the differential equation for forced vibration without damping using the mass- spring-dash pot system. Derive the solution.
2. Mention various dynamic properties of soil. Explain any one in detail
3. What is meant by dynamic bearing capacity? Under what situations, dynamic bearing capacity is required?
4. Explain the General requirements of Machine Foundations-
5. Sketch a typical Machine-isolator-foundation system acting as motion isolation.

(5 x 5 = 25 marks)

PART B
(Answer any 5 Questions)

6. a. What is mean by Resonance condition?
b.A Foundation weighs 1150 kN.The foundation and the soil can be approximated as a Mass-Spring-Dashpot system. Given the spring constant = 24500 kN/m,Dash pot coefficient = 4100 kN-Sec/m .Determine (i) Critical damping coefficient (ii) Damping ratio (iii) Logarithmic decrement and (iv) Damped natural frequency.

7. a Explain the various type of dynamic loads encountered in soil engineering practice
b. Determine the natural frequency of a machine foundation having a base area of 1.8 m ×1.8 m and a mass of 180 kN, including the mass of machine. Take $C_u = 5.2\times 10^4$ kN/m^3 (i) if mass of soil is neglected and (ii) if mass of soil is 22 % of the mass of foundation and machine.

8. Describe with sketches, the method of conducting block vibration test. Explain how the soil parameters are determined by conducting block vibration test ?

9. In a down-hole survey a seismic source generated shear waves and the arrival of first shear wave at various depths in a bore hole were recorded and presented in the following table. Calculate the shear wave velocity and estimate the shear modulus of each layer. Water table is at the surface and saturated density of each layer may be assumed to be 18.5 kN/ m^3

Depth(m)	2.0	3.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0
Time ($\times 10^{-3}$ seconds)	13.5	20.0	26.5	38.0	46.3	53.5	62.0	70.0	76.7	80.0

10.A 4.5 m high retaining wall with back face vertical retains cohesion less back fill ($\phi = 32°$; $\gamma = 17.0$ kN/m^3 ; $\delta = 20°$) .The back fill surface is horizontal. Determine the weight of the retaining wall (i) for static condition (ii) for a displacement of 35 mm under earth quake loading. The retaining wall is located in a seismic region ($\alpha_h = 0.10$ and $\alpha_v = 0.05$) .Use Richard-Elms model or any suitable method.

11. (i)A machine having a mass of 105 kg and supported on springs of total stiffness 800 N/mm has an unbalanced rotating element, which results in a disturbing force of 400 N at a frequency of 52 Cycles per second..Assuming a damping factor of 0.22, determine (i) Amplitude of motion due to unbalance (ii) Transmissibility (iii) Transmitted force

(ii) In a central impact hammer foundation, the weight of the hammer is 23kN and the height of drop is 1.0 m. The efficiency of hammer is 71 % and the weight of Anvil is 530kN. The coefficient of restitution is 0.33. Compute the initial velocity of motion of centre of foundation

12. Explain the mechanism of liquefaction of soil with relevant formulae. Also explain assessment of susceptibility of a soil to liquefaction.Which type of soil is more susceptible to liquefaction and why?

(5 x 7 = 35 marks)

Syllabus and Course Plan

No	Topic	No. of Lecture hours
1	**Module 1**	**08 hours**
1.1	Introduction: Comparison of Soil mechanics and Soil Dynamics, Classification of dynamic loads, Nature of Dynamic loads.	01
1.2	Theory of Vibration: Definitions, Degrees of freedom-Harmonic motion, Mass spring dash model for soil dynamics problems- free andforced Vibration of a single degree freedom system with andwithout damping-Magnification factor-Transmissibility- Rotating mass type excitation	05
1.3	Stress conditions on soil element under earthquake loading, seismic force for pseudo static analysis as per IS Code-Seismic coefficient method-Response spectrum method	02
2	**Module 2 Dynamic Soil Properties**	**08**
2.1	Dynamic Soil Properties: Dynamic moduli, Dynamic elastic constants, Poisson's Ratio, Damping ratio, Liquefaction parameters	01
2.2	Introduction to wave propagation in elastic half space-wave propagation through soil –	01
2.3	Vertical Block Resonance Test –Horizontal Block Vibration Test- seismic refraction test-Seismic bore hole test- Cyclic simple shear test, Cyclic Triaxial Compression Test- Shear Modulus and Damping Ratio in Sand and in Clays -Cyclic Plate Load Test- SPT	06
3	**Module 3:- Dynamic Earth Pressure and bearing capacity**	**08**
3.1	Dynamic Earth Pressure: Pseudo static methods-Modification of Coulomb's theory -Mono nobe- Okabe method for active and passive case-Modified Colman's graphical method	04
3.2	Dynamic Earth Pressure- Displacement Analysis- Richard – Elms Model- Solution in pure translation	02
3.3	Dynamic bearing capacity of shallow foundations-Pseudo static analysis- Seismic bearing capacity in granular soils using the Richard et.al method- Analysis for transient horizontal and transient vertical loads.	02
4	**Module 4 :- Machine Foundation**	**08**

4.1	Types of Machine Foundations-Foundation for Reciprocating Machines- Linear weight less Elastic Spring Method-Modes of vibration-Vertical Vibrations-General requirements of Machine Foundations-Design procedure for a block foundation- IS Code specifications	04
4.2	Foundations of Impact type machines-Hammer Foundations-Dynamic Analysis using Mass- Spring Model-Design Procedure-IS Code Specifications	02
4.3	Analysis and design using Elastic half space approach-Construction aspects ofMachine Foundations.	02
5	**Module 5**	**08**
5.1	Vibration Isolation: Force Isolation – Motion Isolation – use of spring and damping materials –	03
5.2	Screening of vibration –Active and Passive screening-opentrenches – Pile Barriers	02
5.3	Liquefaction of Soils: Definition, causes- Soil types-Mechanism- Evaluation of zone of liquefaction in field. Evaluation of liquefactionusing Standard Penetration Resistance. Factors affectingliquefaction and measures for avoiding liquefaction.	03

Reference Books

1. Swami Saran “Soil Dynamics and Machine Foundation” Galgottia Publication Pvt. Ltd.,New Delhi.
2. Shamsher Prakash “Soil Dynamics” Mc-Graw Hill, New York.
3. Sreenivasalu & Varadarajan “Handbook of Machine Foundation” Tata McGraw Hill.
4. Braja M. Das & G. V. Ramana, “ Principles of Soil Dynamics” Cengage Learning, USA
5. Bhatia K.G., “Foundation for Industrial Machines – Handbook for Practicing Engineers” D -CAD Publishers, New Delhi.
6. Moore P.J “Analyis and Design of Foundations for vibrations
7. IS 2974 (Part 1 and 2) “Code of Practice for Design and Construction of Machine Foundations, Bureau of Indian Standards, New Delhi

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE034	SUSTAINABLE GEOTECHNICS	PROGRAMME ELECTIVE 4	3	0	0	3

Preamble: To impart in-depth knowledge of the modern skills and tools related to Environmental Geotechnical engineering so as to enable them to address the environmental aspects and sustainable issues related to infrastructure development of the country.

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

CO 1	To understand the principles of sustainable development
CO 2	To conduct environmental assessment and environmental management
CO 3	To understand the source and extent of environmental emergencies
CO 4	To apply the inter relationship between ability and efficient use of resources in geotechnical application
CO 5	To decide on the sustainable reuse of waste material for geotechnical applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	3	2	3	
CO 2	3	2	3	3	2	3	
CO 3	3	2	3	3	2	3	
CO 4	3	2	3	3	2	3	
CO 5	3	2	3	3	2	3	
CO 6	3	2	3	3	2	3	

Assessment Pattern

Bloom's Category	End Semester Examination(%)
Apply	70
Analyse	30
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such
questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question Paper

APJ Abdul Kalam Technological University
M.Tech Degree Examination
Branch: Geotechnical and Geoenvironmental Energy
Subject: SUSTAINABLE GEOTECHNICS
Time: 2.5 Hrs Max. Marks: 60

PART A
(Answer All Questions)

1. Explain the Principles of Sustainable Development.

2. Describe the regulatory standards for industrial wastewaters and atmospheric emission

3. Illustrate the major environmental emergencies in recent history

4. Describe the latest development in climate change policies & CDM?

5. Explain in detail the Geotechnical Reuse of Waste materials. (5x5=25)

PART B
(Answer any 5 Questions)

6. Explain the major challenges to successful Infrastructure Planning and Implementation

7. Interpret the Environmental policy & Indian environmental legislations and environmental acts

8. Discuss the different types of Environmental Emergencies

9. Explain the significance of Civil Engineering in the context of sustainable waste management in global cities and developing countries

10. Explain the Sustainable urban underground structures development

11. Discuss the use of waste material in Embankment and Fills

12. Explain the Environmental impact of disasters (5 x 7 = 35 marks)

Syllabus and Course Plan

No	Topic	No. of Lectures
Module I (8 hours)		
1.1	Principles of Sustainable Development: Challenges to Successful Infrastructure Planning and Implementation	1
1.2	Mapping and Facing the Landscape of Risks in Infrastructure Projects	1
1.3	Economic and Demand Risks:	1
1.4	The Case study for Political Risks,	1
1.5	Cultural Risks in International Infrastructure Projects	1
1.6	Legal and Contractual Issues in Infrastructure Challenges in Construction	1
1.7	Construction and Maintenance of Infrastructure	1
1.8	Socio-Environmental Risks	1
Module II (9 hours)		
2.1	Sustainable development and strategies	1
2.2	Waste minimization and pollution prevention strategies – cleaner technologies	1
2.3	Tools of corporate environmental management	1
2.4	Environmental policy, Environmental management systems; ISO: 14000	1
2.5	Environmental Impact assessment	1
2.6	Indian environmental legislations and environmental acts	1
2.7	Life cycle assessment	1
2.8	environmental labelling, environmental audit	1
2.9	Environmental performance assessment; regulatory standards for industrial wastewaters and atmospheric emission	1
Module III (6 hours)		
3.1	Environmental Emergencies: Nature of the Hazards	1
3.2	Type of Environmental Emergencies – oil spills, industrial accidents, forest fires	1
3.3	Natural disasters and environmental emergencies	1
3.4	Major environmental emergencies in recent history	1
3.5	Environmental impact of disasters	1
3.6	Economic cost of environmental emergencies.	1
Module IV (8 hours)		
4.1	Sustainability and resource efficiency	1
4.2	steps towards designing out waste and maximising the value of outputs from waste treatment processes	1

4.3	Interface of waste and resource management	1
4.4	Civil engineering in the context of sustainable waste management in global cities and developing countries	1
4.5	Latest development in climate change policies & CDM	1
4.6	Introduction to Reliability analysis of sequential failures	1
4.7	Application	1
4.8	Consideration for materials flow through the economy	
Module V (9 hours)		
5.1	Sustainable urban underground structures development,	1
5.2	Geotechnical Reuse of Waste materials	1
5.3	Waste reduction, use in geotechnical construction,	1
5.4	waste characteristics	1
5.5	transportation consideration	1
5.6	Engineering properties of Wastes	1
5.7	Waste material in Embankment and Fills	1
5.8	Low carbon project cycle –ground engineering.	2

Reference Books

1. Richard Welford, Corporate Environmental Management Systems and Strategies, Universities Press (I) Ltd., Hyderabad, 1996.

2. Paul L. Bishop, Pollution Prevention: Fundamental and Practice, McGraw Hill, International, 2000.

3. Freeman, H.M., Industrial Pollution Prevention Handbook, McGraw Hills 1995.

4. Allen ,D.T and Shonnard ,D. R ., Sustainability Engineering :Concepts ,Design and Casestudies , Prentice Hall.

5. Bradley.A.S., Adebayo A.O., Maria P, Engineering applications in sustainable development ,Cengage Learning .

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE035	EARTH AND ROCK FILL DAMS	PROGRAMME ELECTIVE 4	3	0	0	3

Preamble: The course is designed to provide fundamental knowledge on the types, design criteria, and stability of earth and rockfill dams. It enables the students to select and design appropriate design techniques to avoid failure.

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

CO 1	Understand the requirements and characteristics of earth and rock fill dams.
CO 2	Understand the factors influencing design of embankment dams.
CO 3	Analyse various seepage conditions and methods to control them.
CO 4	Understand the role of pore pressure in stability analysis.
CO 5	Capable to identify causes of failure of dams and apply the concepts of construction methods.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	1	3	3	3	1	1
CO 2	3	1	2	3	3	1	1
CO 3	2	1	2	3	3	1	1
CO 4	2	1	2	2	3	2	1
CO 5	2	1	3	3	3	2	1
CO 6	3	1	3	2	3	2	1

Assessment Pattern

Bloom's Category	End Semester Examination(%)
Apply	20
Analyse	35
Evaluate	30
Create	15

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus

End Semester Examination Pattern:
There will be two parts; Part A and Part B.

Part A contains 5 questions with 1 question from each module having 5 marks for each question. Students should answer all questions.

Part B contains 2 questions from each Module 7 marks of which student should answer any one question from each Module.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION

Branch: **Geotechnical Engineering**

Stream:CE3

Subject: EARTH AND ROCK FILL DAMS

PART A **Marks**
(Answer All Questions) **(25 marks)**

1.	Describe briefly about the requirements of a good earthdam site.	(5marks)
2.	Explain in detail about reliefwell and its application in an earthdam.	(5marks)
3.	Defineaflownet.Whatarethepropertiesofaflownet?	(5marks)
4.	What are the different types of slope failures?	(5marks)
5.	Explain how earth and rockfill dam construction can be improved using Geosynthetics.	(5marks)

PARTB
(Answer any 5 Questions) **(35 marks)**

1	(a) Draw the cross-section of an earth dam, designed for a site where both clayey silt and coarse sand are available, and foundation is pervious to a depth more than 15m.	(3marks)
	(b) Explain about rock fill dams and its general characteristics.	(4marks)
2	Explain the construction sequence of the embankment of an earthdam.	(7marks)
3	Explain the Kozney's solution for determining the equipotential (φ) and flow (ψ)curves.	(7marks)
4	Estimate the quantity of seepage and sketch the phreatic line and flownets, for a homogeneous earth dam with top width 5m, height of the dam 30m, freeboard 3m, length of horizontal drain 45m, upstream and downstream slope2: 1, and soil having permeability $1.5x10^{(-6)}$m/s.	(7marks)
5	Describe briefly about the role of pore pressure in slope stability analysis of earth dam under sudden drawdown conditions.	(7marks)
6	Explain briefly about New mark's approach for seismicstability analysis.	(7marks)
7	Enumerate and describe briefly the type of failures and damages occur in an earthdam.	(7marks)

Syllabus and Course Plan

No	Topic	No. of Lectures
1	**Module 1: Introduction to earth and rockfill dams**	
1.1	Types of earth dams, study on earth dams in Kerala	1
1.2	Requirements of a good dam site, Selection & Requirements of foundation Material for construction ;	2
1.3	Typical cross section of an earth dam, Different sections of earth dams	1
1.4	Rock fill dams- General characteristics;	1
1.5	Control of rock fill placement, Settlement of rock fill;	1
2	**Module 2: Design considerations**	
2.1	Criteria for safe design of embankment dams	1
2.2	Types of filters and filter design	1
2.3	Impervious membrane and Selection of core types;	1
2.4	Upstream blanket – relief wells	1
2.5	Cut off trenches – Grout curtains;	1
2.6	Embankment construction- Methods of placement and compaction, Compaction control; Placement water content. ;	3
3	**Module 3: Seepage through dams**	
3.1	Stream lines, equipotential line, flownet for a homogeneous earth dam;	1
3.2	Determination of phreatic line using Casagrande's solution;	2
3.3	Kozheny's parabola-Entrance & Exit correction;	2
3.4	Seepage analysis - under steady seepage and sudden draw down conditions;	1
3.5	Adverse effects of seepage; Methods of reducing seepage	1
4	**Module 4: Stability of Slopes**	
4.1	Types of slope and failures, Method of Slices	1
4.2	Role of pore pressure in stability analysis- during construction, steady seepage & sudden drawdown conditions.	3
4.3	Seismic stability- New marks approach	2
4.4	Goodman and Seeds approach;	1
5	**Module 5: Failure of dams**	
5.1	Types of failure and damages of embankment dams	1
5.2	Movement of crest and its measurement.	1
5.3	Embankment compressibility and swelling ;	1
5.4	Methods of Slope protection;	1
5.5	Methods to safeguard dams during earthquakes.	1
5.6	Applications of geosynthetics in earth and rock fill dam	1

References:

1.Sherad , Earth and Rockfill dams, Principles for Design and Construction, Balkema, Netherlands.

2.Bharat Singh and Punmia , Earth and Rockfill dams, Standard publishers, New Delhi, 1988.Earth Manual –USBR

3. US Army Corp of Engineers, Earth and Rock-fill Dams, General Design and construction Considerations, University Press of the Pacific (2004)

4.Rowe,R K., Geotechnical and Geoenviornmental Engineeing Handbook, Kulwer Acadamic Publishers,2001

5.Sherard,J L.,WoodwardRJ,Gizienski, R J and Clevenger W A., Earth and Earth rock dam, John Wiley.

SEMESTER II

INTERDISCIPLINARY ELECTIVE

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE097	MECHANICS OF COMPOSITE MATERIALS	INTERDISCIPLINARY ELECTIVE	3	0	0	3

Preamble: Fibre reinforced plastic composite materials are finding wide range of applications in the field of aerospace structures, automobile engineering, offshore structures, maritime structures, ships and civil engineering structures presently due to its outstanding material capabilities such as High strength, low weight, high corrosion resistance, high fatigue strength and faster assembly. The everyday applications of composites in the commercial markets and hence the job opportunities in this field are drastically increasing nowadays. This course will equip the students with the specialist knowledge and skills required by the leading employers in aerospace, marine, automobile, construction and renewable energy industries to design and develop next generation environmental-friendly and structural-efficient advanced lightweight composite materials and components.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.

After the completion of the Advanced Composite Structures course the student will be able to

CO 1	Identify the properties of fibre and matrix materials used in commercial composites, as well as some common manufacturing techniques.
CO 2	Explain linear elasticity with emphasis on the difference between layered composite materials and isotropic materials.
CO 3	Apply constitutive equations of composite materials and understand the mechanical behaviour at micro and macro levels.
CO 4	Predict the failure mode and strength of laminated composite structures.
CO 5	Apply the ideas developed in the analysis of composites towards using composites in various fields of engineering.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	3	2		
CO 2			3	3	2		
CO 3			3	3	2		
CO 4			3	3	2		
CO 5			3	3	2		

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	15
Understand	15
Apply	25
Analyse	5
Evaluate	-
Create	-

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): 15 marks
Course based task/Seminar/Data collection and interpretation: 15 marks
Test paper, 1 no.: 10 marks
Test paper shall include minimum 70% of the syllabus.

End Semester Examination Pattern:
The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the

average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40 + 20 = 60 %.

Model Question paper

PART A

Answer **all** questions.

All Questions carry **equal** marks

1. How is the mechanical advantage of a composite measured?
2. Write the number of independent elastic constants for three dimensional anisotropic, orthotropic, transversely isotropic and isotropic materials.
3. What is Classical Lamination Theory? Explain its significance in composite analysis.
4. The weight fraction of glass in a glass epoxy composite is 0.8. If the specific gravity of glass and epoxy are 2.5 and 1.2 respectively, find (i) fibre and matrix volume fractions (ii) density of composite?
5. Explain briefly the progressive failure analysis in a composite laminate.

PART B

Answer any **FIVE** questions only

6. Briefly explain the Hooke's law for Anisotropic materials. Derive the stress-strain relation for a material with three planes of reflection and one 90◦ rotation symmetry
7. (a) Explain any two methods of manufacturing of composite in detail.
   (b) Derive the relations connecting the engineering constants and the elements of stiffness and compliance matrices for a specially orthotropic lamina.
8. (a) Calculate the longitudinal modulus and tensile strength of a unidirectional composite containing 60% by volume of carbon fibres (E_{1f} = 294 GPa and σ_{1fu} = 5.6 Gpa) in a toughened epoxy matrix (E_m = 3.6 GPa and σ_{mu} = 105 Gpa). Compare these values with the experimentally determined values of E_1 = 162 GPa and σ_{1u} = 2.94 GPa. What fraction of load is carried by fibres in the composite?
   (b) Explain how to calculate the effective modului of a composite lamina in terms of its constituent properties.
9. (a) Explain the free edge effects and interlaminar stresses in composite laminates
   (b) Explain how to determine the laminae stresses and strains from the analysis of a laminate?
10. Calculate the A, B , D matrices for a [0/90°] laminate each layer of which is of 0.125 mm thickness. The lamina properties are given by E_1 = 140 GPa, E_2 = 10 GPa, G_{12} = 5 GPa, υ_{12} = 0.3
11. (a) Explain the effect of interlaminar stresses in composite laminate in detail
    (b) Explain the importance of the sign of shear stress on strength of composites.

12. Find the maximum value of S>0 if a stress of σ_x = 2S, σ_y = -3S, and τ_{xy} = 4S is applied to a 60° Graphite/epoxy Lamina. Use Tsai-Hill Failure theory.
Given $(\sigma_1^t)_{ult} = 1500MPa, (\sigma_1^C)_{ult} = 1500MPa, (\sigma_2^t)_{ult} = 40MPa, \ (\sigma_2^C)_{ult} = 246MPa,$
$(\tau_{21})_{ult} = 68MPa$

Syllabus and Course Plan

No	Topic	No. of Lectures
1	**Introduction to Composite Materials (6)**	
1.1	Definition of composites, Objectives, constituents and Classification of composites.	2
1.2	Basic terminology used in fibre reinforced composite materials- Lamina, Laminates ,General Characteristics of reinforcement and classifications, Characteristics of matrix- Polymer matrix, Thermoplastics and thermosetting resins, Glass transition temperature , Prepregs	2
1.3	Structural applications of Composite Materials	1
1.4	Processing of Composites	1
2	**Macro mechanical behaviour of a composite lamina (9)**	
2.1	Review of Basic Equations of Mechanics and Materials, Hooke's law for different types of materials- Anisotropic, orthotropic, isotropic, monoclinic and Transversely isotropic materials.	2
2.2	Stress-Strain relations for a Two dimensional unidirectional and orthotropic lamina, lamina of arbitrary orientation, Transformations of stress and strain	3
2.3	Relationship of Compliance and stiffness matrix to elastic constants of a lamina	1
2.4	Strength and Failure theories of Continuous Fibre-reinforced orthotropic Lamina- Failure envelopes, Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion.	2
2.5	Hygrothermal stresses and strains in a lamina –unidirectional and angle lamina	1
3	**Micromechanical Behaviour of a Lamina (6)**	
3.1	Volume and Mass fractions, density and void content	1
3.2	Effective Moduli of a continuous fibre-reinforced lamina – Models based on mechanics of materials, theory of elasticity and experimental methods, Mechanics of materials approach to strength, Numerical Examples	2
3.3	Ultimate Strengths of unidirectional Lamina- longitudinal and transverse tensile and compressive strengths	2
3.4	Coefficients of moisture and thermal expansion	1
4	**Macro mechanical behaviour of Laminates (10)**	

4.1	Classical Lamination Theory-Laminae Stress-strain behaviour, In-plane forces, stress-strain variation in a laminate, resultant laminate stresses and strains,	3
4.2	Special cases of laminate stiffnesses-symmetric and antisymmetric laminates, cross ply and angle ply laminates, quasi-isotropic laminates	3
4.3	Inplane and flexural modulus of a laminate	1
4.4	Effects of stacking sequence-Laminate code	1
4.5	Free-Edge Interlaminar Effects, Hygro-thermal effects and warpage in a laminate	2
5	**Strength and Design of Laminates (9)**	
5.1	Determination of laminae stresses and strains, numerical examples	2
5.2	Laminate strength analysis procedure, Failure envelopes	3
5.3	Analysis of laminates after initial failures, Progressive failure Analysis. Numerical Examples	2
5.4	Composite mechanical design issues-Long-term environmental effects, impact resistance, fracture resistance, fatigue resistance	2

Text Books

1. Jones M. Roberts, Mechanics of Composite Materials, Taylor and Francis,1998
2. Reddy, J.N , Mechanics of Laminated Composite Plates: Theory and Analysis, CRC Press, 2003

Reference Books

1. Calcote, L. R., Analysis of Laminated Composite structures, Van Nostrand, 1969
2. Vinson, J. R. and Chou P, C., Composite materials and their use in Structures, Applied Science Publishers, Ltd. London, 1975
3. Agarwal, B.D. and Broutman, L. J., Analysis and performance of Fibre composites. 3rdEdn.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222ECE098	PROJECT EVALUATION AND MANAGEMENT	INTERDISCIPLINARY ELECTIVE	3	0	0	3

Preamble: Objective of the course is to enable the students to understand the management aspects of project idea formulations, feasibility studies and report preparation, costing of project, project appraisal and project funding.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.

After the completion of the course the student will be able to

CO 1	To develop project ideas
CO 2	To do the feasibility analysis of projects
CO 3	To plan and arrive at Project Costs
CO 4	To carry out project appraisals
CO 5	To identify the various funding sources and select the apt source

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2		3	2		2	
CO 2	2		2				
CO 3	3	2		3			
CO 4	2		2	2	2		
CO 5	2		2	1			

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	20
Apply	10
Analyse	10
Evaluate	20
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed

Original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks. Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Model Question Paper

Model Question paper

Course Code & Name:

Project Evaluation and Management

Max. Marks: 60
Duration: 2.5 hours

PART A

(Answer all Questions: Each question carries 5 marks)

1. Discuss the need for project idea generation ?
2. Why feasibility studies are essential?
3. What do you understand by Present value of a single amount?
4. Explain the international practice of Project Appraisal.
5. Discuss the means of Project Financing.

PART B

(Answer any *five* questions: Each carries 7 marks)

6. Describe the various steps involved in Project Identification.
7. How will you assess the technical feasibility of a project?
8. Explain cash flow and what are the benefits of cash flow statement..
9. Discuss the various methods of Risk Analysis
10. Bluebell Enterprises had invested Rs.2,00,00,000 for the purpose of replacing some of its machinery components. This renovation is expected to result in incremental benefits of Rs.5000000 in 1st year, Rs.3000000 in 2nd year and Rs. 4000000 in 3rd year. Calculate the benefit-cost ratio of the replacement project if the applicable discounting rate is 5%..
11. Discuss the role of various institutions for project financing
12. Discuss the Private Sector Participation on Infrastructure Projects in India

Syllabus and Corse Plan (For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

No	Topic	No. of Lectures
1	Project formulation	
1.1	Concepts of Project, Capital Investments	2
1.2	Purpose and need for Project Identification	2
1.3	Methodology for Project Identification	2
1.4	Steps in Project Identification	2
2	Project Feasibility	
2.1	Introduction to feasibility Studies, need for feasibility studies	2
2.2	Components of Feasibility Analysis - Market, Technical, Financial, Economic	4
2.3	Feasibility Reports and approvals	2
3	Project Costing	
3.1	Time Value of Money - Future value of single amount, Present value of single amount, Future value of an annuity, Present value of an annuity, Simple interest-Compound interest	3
3.2	Project Cash Flows	3
3.3	Cost of capital	2
4	Project Appraisal	
4.1	Investment Criteria- Discounting criteria-Net present value (NPV), Benefit cost ratio(BCR), internal rate of return(IRR)-Non-Discounting criteria - Pay Back Period, Accounting rate of return(ARR	4
4.2	Indian and International Practice of Appraisal	2
4.3	Methods of Analysis of Risk	2
5	Project Financing	
5.1	Project Financing – Means of Finance	2
5.2	Financial Institutions, schemes	3
5.3	Private sector participation in Infrastructure Development Projects - BOT, BOLT, BOOT	2
5.4	Technology Transfer and Foreign Collaboration	1

Reference Books

1 Project Planning Analysis selection financing Implementation and Review- Tata Mc Graw Hill Publication, 7th edition 2010, Prasana Chandra

2 United Nations Industrial Development Organization (UNIDO) Manual for the preparation of Industrial Feasibility Studies, (IDSI Reproduction), Bombay, 2007.

3 A Systems Approach to Planning, Scheduling, and Controlling Project Management Harold Kerzner (2013), Wiley India, New Delhi

4 Project planning scheduling & control, James P.Lawis, Meo Publishing Company 2001

5 Project planning analysis selection implementation & review Prasanna Chandra, ISBNO-07-462049-5 2002.