
SEMESTER V

CIVIL ENGINEERING

CORE COURSES – S5

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	CET301	STRUCTURAL ANALYSIS – I	3-1-0	4	4
B	CET303	DESIGN OF CONCRETE STRUCTURES	3-1-0	4	4
C	CET305	GEOTECHNICAL ENGINEERING – II	4-0-0	4	4
D	CET307	HYDROLOGY & WATER RESOURCES ENGINEERING	4-0-0	4	4
E	CET309	CONSTRUCTION TECHNOLOGY & MANAGEMENT	3-0-0	3	3
F	MCN301	DISASTER MANAGEMENT	2-0-0	2	--
S	CEL331	MATERIAL TESTING LAB – II	0-0-3	3	2
T	CEL333	GEOTECHNICAL ENGINEERING LAB	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4*	4
TOTAL				27/31	23/27

MINOR COURSES - S5

R/M	CET381	STRUCTURAL MECHANICS	3-1-0	4	4
R/M	CET383	ECO-FRIENDLY TRANSPORTATION SYSTEMS	3-1-0	4	4
R/M	CET385	SUSTAINABILITY ANALYSIS & DESIGN	3-1-0	4	4

HONOURS COURSES - S5

R/M/H	CET393	STRUCTURAL DYNAMICS	3-1-0	4	4
R/M/H	CET395	TRANSPORTATION SYSTEMS MANAGEMENT	3-1-0	4	4
R/M/H	CET397	GROUND WATER HYDROLOGY	3-1-0	4	4

CET301	STRUCTURAL ANALYSIS - I	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	3	1	0	4	2019

Preamble:

The course enables the students to analyse various types of simple structures using appropriate methods and tools. It introduces the applications of principles of mechanics of solids to determine stress resultants in statically determinate and indeterminate structures. Specific cases of cables, suspension bridges and arches are also discussed at length. The course trains the students to develop mathematical models and helps to sharpen their analytical skills. After this course students will be able to analyse structures subjected to moving loads as well.

Prerequisite: CET201 Mechanics of Solids

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	Apply the principles of solid mechanics to analyse trusses.	Applying
CO2	Apply energy principles to analyse statically determinate structures.	Applying
CO3	Identify the problems with static indeterminacy and understand the basic concepts of tackling such problems by means of the method of consistent deformations.	Understanding, Analysing
CO4	Apply suitable methods of analysis for various types of structures including cables, suspension bridges and arches.	Applying
CO5	Analyse the effects of moving loads on structures using influence lines.	Analysing
CO6	Apply specific methods such as slope deflection and moment distribution methods of structural analysis for typical structures with different characteristics.	Applying

Mapping of course outcomes with program outcomes (Minimum requirement)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-
CO6	3	2	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	05	10
Understand	20	10	20
Apply	30	25	50
Analyse	10	10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

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

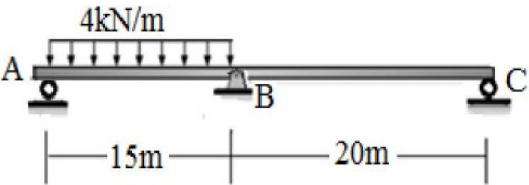
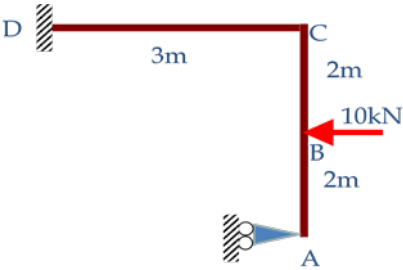
Course Level Assessment Questions

CO1: Apply the principles of solid mechanics to analyse trusses.

1.	Explain the method of joints to analyse trusses.
2.	Find the member forces in FH, EH and EG using method of sections.
3.	Analyse the truss in figure using method of joints

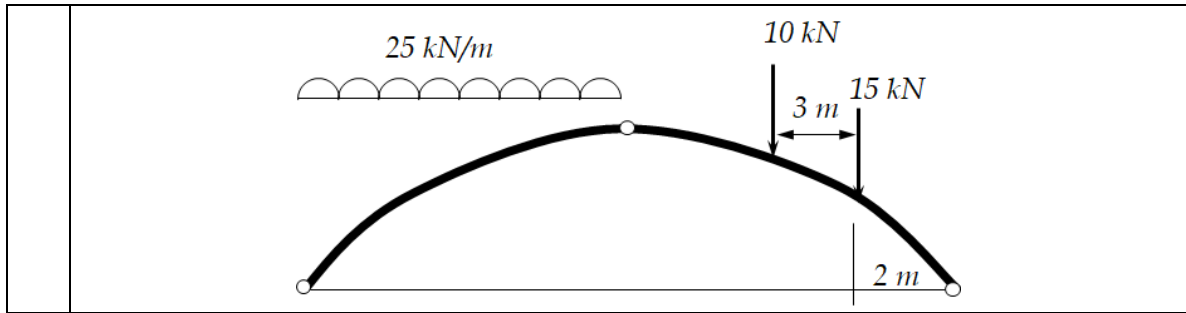
CO2: Apply energy principles to analyse statically determinate structures.

1.	Find from first principles, the shear strain energy in bending for a cantilever with uniform cross section, width 200mm, depth 300mm and span 3m. A point load of 10kN is acting at the free end. $E= 2 \text{ MN/m}^2$.
2.	State and prove Betti's Theorem.
3.	Find the bending strain energy for a cantilever of span 3m with a point load of 10kN at the free end. Cross section is 200X300mm. $E= 2 \text{ MN/m}^2$.
4.	Find the vertical deflection at C for the frame in figure using strain energy method.

CO3:	Identify the problems with static indeterminacy and understand the basic concepts of tackling such problems by means of the method of consistent deformations.
1.	Explain static and kinematic indeterminacies with examples.
2.	Differentiate between force and displacement methods for analysing indeterminate structures
3.	Find the reaction at B for the beam shown in figure, using consistent deformation method. 
4.	Analyse the 2D frame using consistent deformation method (EI is constant). 

CO4: Apply suitable methods of analysis for various types of structures including cables, suspension bridges and arches.

1.	Write a note on three-hinged and two-hinged stiffening girders.
2.	State and explain Eddy's theorem
3.	For a cable AB, the level difference between the supports A and B is 6m, and the lowest point is at a vertical distance of 4.5m from A. If the horizontal span AB is 24m and is loaded with 7.5kN/m throughout the span, find the length of the cable, and the minimum and maximum tension in the cable
4.	A suspension bridge with 25m span and central dip 2.5m transfers 4kN per horizontal metre to each cable. Find max and min pull in each cable, and the length of cable
5.	The span of the 3-hinged parabolic arch shown in figure is 30m and the rise is 6m. Find BM, normal thrust, and radial shear at a section 7.5 m from the left hinge. Find maximum BM on the arch.

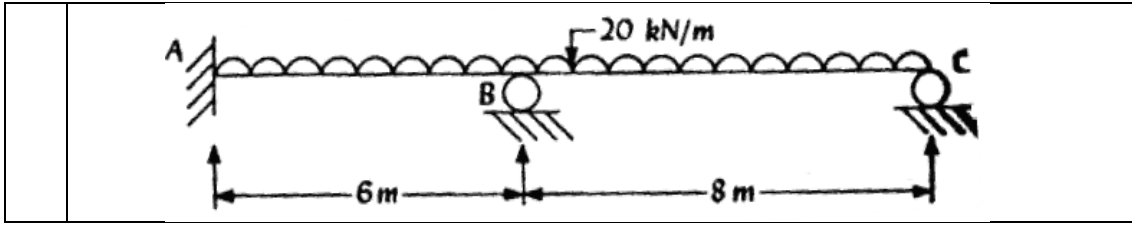


CO5: Analyse the effects of moving loads on structures using influence lines.

1.	State and explain the condition for absolute maximum bending moment in a simple beam when a series of concentrated loads is moving across it
2.	What are influence lines? Draw ILD for SF and BM at any intermediate section of a simply supported beam. What are the uses of influence lines?
3.	Four point loads 30kN, 40kN, 20kN and 15kN, distance between them being 2m, are moving across a simple beam (of span 15m) from left to right with 30kN load leading. Find position of the loads for maximum -ve SF and BM at a section 7m from left end. Also find maximum -ve SF and BM at the section.

CO6: Apply specific methods such as slope deflection and moment distribution methods of structural analysis for typical structures with different characteristics.

1.	Explain briefly on the analysis of frames with sidesway, using slope deflection method
2.	Derive expressions for stiffness at the near-end for a beam with hinged far-end
3.	Analyse the continuous beam using slope deflection method (EI is constant). <div style="text-align: center;"> </div>
4.	Analyse the continuous beam in figure using moment distribution method (EI is constant)



SYLLABUS

Module – 1

Statically determinate structures:

Trusses: Method of joints and method of sections (Numerical problems) – 4 hrs.

Elastic theorems and energy principles: strain energy due to axial load, bending moment, shear and torsion - strain energy method, Castigliano's method for deflection (Derivations only). – 4 hrs.

Betti's theorem – Maxwell's law of reciprocal deflections - 1 hr.

Module – 2

Principle of least work; Application of unit load method and strain energy method for determination of deflection of statically determinate beams, frames - pin jointed trusses (simple numerical problems) – 4 hrs.

Concepts of temperature effects and lack of fit(No numerical problems) – 1 hr.

Statically indeterminate structures:

Degree of static and kinematic indeterminacies – Introduction to force and displacement methods - 1 hr.

Method of Consistent deformations: Analysis of beams frames and trusses with internal and external redundancy (Simple problems with maximum one redundant – Illustration only for two redundants)– 3 hrs.

Module – 3

Method of Consistent deformations (continued): Concepts of effect of prestrain, lack of fit, temperature changes and support settlement. (No numerical problems) – 1 hr.

Cables: Analysis of forces in cables under concentrated and uniformly distributed loads - Anchor Cable supports – 4hrs.

Suspension Bridges: Un-stiffened suspension bridges, maximum tension in the suspension cable and backstays, pressure on towers – 4 hrs.

Module – 4

Arches: Theory of arches – Eddy's theorem - analysis of three hinged arches-Support reactions-normal thrust and radial shear at any section of a parabolic arch due to simple cases of loading. – 4 hrs.

Moving loads and influence lines: Introduction to moving loads - concept of influence lines - influence lines for reaction, shear force and bending moment in simply supported beams and over hanging beams - analysis single concentrated load, several concentrated loads, uniformly distributed load shorter and longer than the span. – 5 hrs.

Module – 5

Slope Deflection Method: Analysis of continuous beams and portal frames without sway. Frames with sway (illustration only). Settlement effects (derivation only) – 4hrs.

Moment Distribution Method: Analysis of beams and frames – non sway analysis. Sway analysis (illustration only) – 4 hrs.

Introduction to structural analysis softwares (hands on exercises on two simple structural analysis problems) – 1 hr.

Text Books:

1. Gere and Timoshenko, Mechanics of materials, CBS Publishers
2. Kenneth Leet, Chia M Uang & Anne M Gilbert, Fundamentals of Structural Analysis, McGraw Hill
3. R.Vaidyanathan and P.Perumal, Comprehensive Structural Analysis Volume I & II, Laxmi Publications (P) Ltd

References:

1. Wang C.K., Intermediate Structural Analysis, McGraw Hill
2. Aslam Kassimali., Structural Analysis, Cenage Learning
3. Chandramouli P N, Structural Analysis I –Analysis of Statically Determinate Structures, Yes DeePublishing Pvt Ltd.,Chennai,Tamil Nadu.
4. DevdasMenon, Structural Analysis, Narosa Publications
5. Hibbeler., Structural Analysis, Pearson Education
6. Kinney S., Indeterminate Structural Analysis, Oxford & IBH
7. M.L. Gambhir, Fundamentals of structural Mechanics and analysis, Printice Hall India
8. Reddy C.S., Indeterminate Structural Analysis, Tata McGraw Hill
9. Timoshenko S.P.& Young D.H., Theory of Structures, McGraw Hill
10. Daniel L Schodak, Structures, Pearson Education, 7e, 2014
11. Negi L. S. and Jangid R. S, Structural Analysis, Tata McGraw Hill, 1997
12. Rajasekaran S. and Sankarasubramanian G., Computational Structural Mechanics, PHI, 2008
13. S.S. Bhavikatti, Structural Analysis II, Vikas Publication Houses (P) Ltd, 2016
14. Utku S, Norris C. H & Wilbur J. B, Elementary Structural Analysis, McGraw Hill, 1990

Lecture Plan –Structural Analysis I

Module	Topic	Course Outcomes addressed	No. of Lectures
1	Module I: Total lecture hours: 9		
1.1	Statically determinate and indeterminate structures - introduction	CO3	1
1.2	Trusses: Method of joints	CO1	2
1.3	Trusses:Method of sections (Numerical problems).	CO1	1
1.4	Elastic theorems and energy principles: introduction	CO2	1
1.5	Strain energy due to axial load, bending moment, shear and torsion	CO2	2
1.6	Strain energy method, Castigliano's method for deflection (Derivations only).	CO2	1
1.7	Betti's theorem – Maxwell's law of reciprocal deflections.	CO2	1
2	Module II: Total lecture hours: 9		
2.1	Principle of least work; Application of unit load method for determination of deflection of statically determinate beams, frames - pin jointed trusses (simple numerical problems)	CO2	2
2.2	Application of strain energy method(simple numerical problems)	CO2	1
2.3	Application of unit load method and strain energy method: Concepts of temperature effects and lack of fit (No numerical problems)	CO2	1
2.3	Statically indeterminate structures: Degree of static and kinematic indeterminacies - examples – Introduction to force and displacement methods.	CO3	2
2.4	Method of Consistent deformations: Analysis of beams frames and trusses with internal and external redundancy (Simple problems with maximum one redundant – Illustration only for two redundants)	CO3	3
3	Module III: Total lecture hours: 9		
3.1	Method of Consistent deformations: Effect of prestrain, lack of fit, temperature changes and support settlement.	CO3	1

	(No numerical problems)		
3.2	Cables: Analysis of forces in cables under concentrated and uniformly distributed loads	CO4	3
3.3	Anchor Cable supports	CO4	1
3.4	Suspension Bridges: Un-stiffened suspension bridges, maximum tension in the suspension cable and backstays, pressure on towers.	CO4	4
4	Module IV: Total lecture hours: 9		
4.1	Arches: Theory of arches – Eddy’s theorem	CO4	1
4.2	Analysis of three hinged arches-Support reactions-normal thrust and radial shear at any section of a parabolic arch due to simple cases of loading	CO4	3
4.2	Moving loads and influence lines: Introduction to moving loads - concept of influence lines	CO5	1
4.3	Influence lines for reaction, shear force and bending moment in simply supported beams and over hanging beams	CO5	1
4.4	Analysis single concentrated load, several concentrated loads, uniformly distributed load shorter and longer than the span. Conditions for maximum shear and bending moment.	CO5	3
5	Module V: Total lecture hours: 9		
5.1	Slope Deflection Method: Concept and derivation of basic equations	CO3, CO6	1
5.2	Slope Deflection Method: Analysis of continuous beams and portal frames without sway.	CO6	2
5.3	Slope Deflection Method: Frames with sway (illustration only). Settlement effects (derivation only)	CO6	1
5.2	Moment Distribution Method: Concept and derivation of basic equations	CO3, CO6	1
5.3	Moment Distribution Method: Analysis of beams and frames – non sway analysis.	CO6	2
5.4	Moment Distribution Method: Sway analysis (illustration only)	CO6	1
5.3	Introduction to structural analysis software (hands on exercises on two simple structural analysis problems)	CO3	1

MODEL QUESTION PAPER

Reg.No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CET301

Course Name: STRUCTURAL ANALYSIS-I

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions; each question carries 3 marks.

- Explain static and kinematic indeterminacies with examples.
 - State and prove Betti's Theorem.
 - Explain the method of consistent deformations, with an example.
 - Differentiate between force and displacement methods for analysing indeterminate structures.
 - Explain how problems involving temperature change/lack of fit are solved using consistent deformation method.
 - Write a note on three-hinged and two-hinged stiffening girders.
 - State and explain the condition for absolute maximum bending moment in a simple beam when a series of concentrated loads is moving across it.
 - State and explain Eddy's theorem.
 - Explain briefly on the analysis of frames with sidesway, using slope deflection method.
 - Derive expressions for stiffness at the near-end for a beam with hinged far-end.

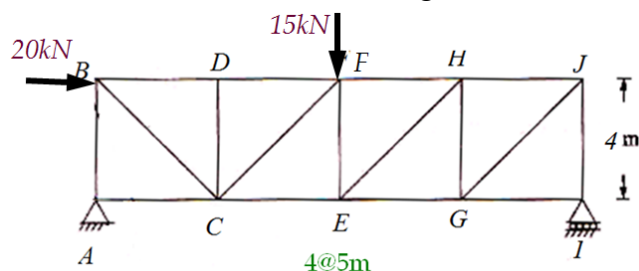
(10×3 marks = 30 marks)

PART B

Answer one full question from each module; each full question carries 14 marks.

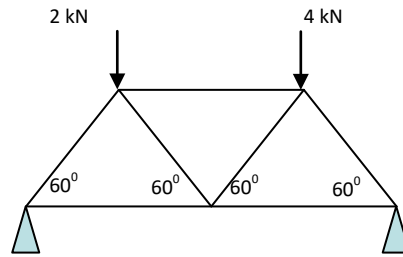
Module I

- Find the member forces in FH and EH and EG using method of sections.



(6 marks)

- Analyse the truss in figure using method of joints.

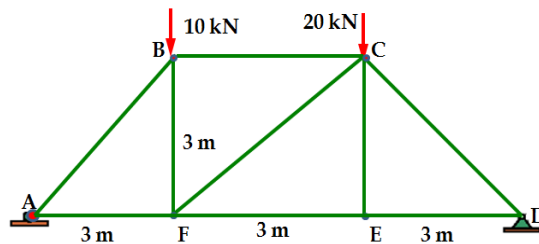


(8 marks)

3. a. Find the bending strain energy for a cantilever of span 3m with a point load of 10kN at the free end. Cross section is 200X300mm. $E= 2 \text{ MN/m}^2$. (7 marks)
- b. Find from first principles, the shear strain energy in bending for a cantilever with uniform cross section, width 200mm, depth 300mm and span 3m. A point load of 10kN is acting at the free end. $E= 2 \text{ MN/m}^2$. (7 marks)

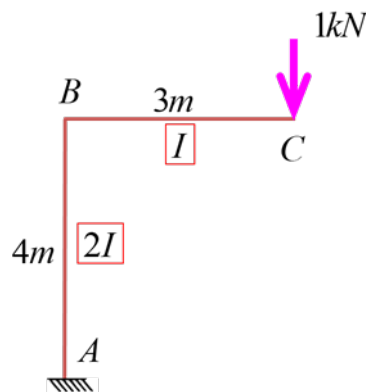
Module II

4. a. Find the deflection at E of the truss in figure, using unit load method. Cross-sectional areas of members are 1200mm^2 . $E= 200 \text{ kN/mm}^2$.



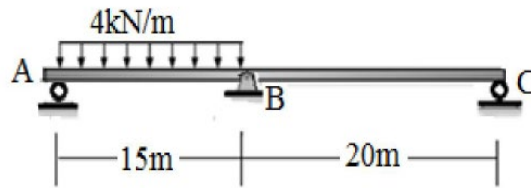
(7 marks)

- b. Find the vertical deflection at C for the frame in figure using strain energy method



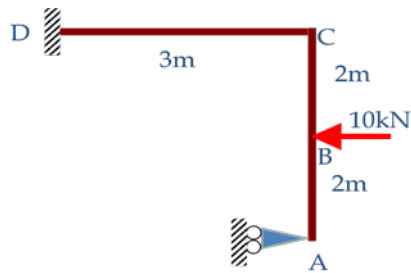
(7 marks)

5. a. Find the reaction at B for the beam shown in figure, using consistent deformation method.



(7 marks)

- b. Analyse the 2D frame using consistent deformation method (EI is constant).



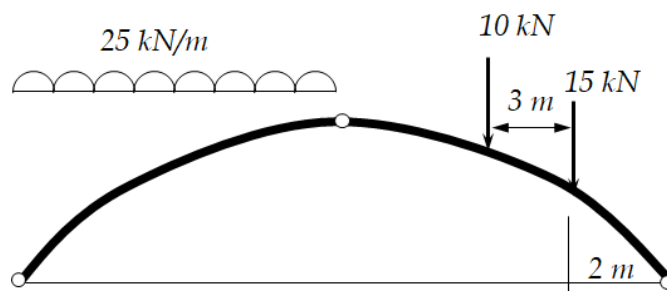
(7 marks)

Module III

6. For a cable AB, the level difference between the supports A and B is 6m, and the lowest point is at a vertical distance of 4.5m from A. If the horizontal span AB is 24m and is loaded with 7.5kN/m throughout the span, find the length of the cable, and the minimum and maximum tension in the cable. (14 marks)
7. A suspension bridge with 25m span and central dip 2.5m transfers 4kN per horizontal metre to each cable. Find max and min pull in each cable, and the length of cable. (14 marks)

Module IV

8. The span of the 3-hinged parabolic arch shown in figure is 30m and the rise is 6m. Find BM, normal thrust, and radial shear at a section 7.5 m from the left hinge. Find maximum BM on the arch.

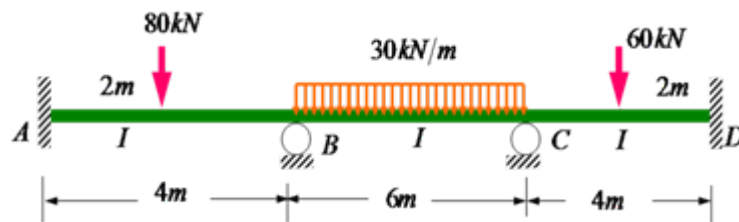


(14 marks)

9. a) What are influence lines? Draw ILD for SF and BM at any intermediate section of a simply supported beam.(5 marks)
- b) Four point loads 30kN, 40kN, 20kN and 15kN, distance between them being 2m, are moving across a simple beam (of span 15m) from left to right with 30kN load leading. Find position of the loads for maximum -ve SF and BM at a section 7m from left end. Also find maximum -ve SF and BM at the section. (9marks)

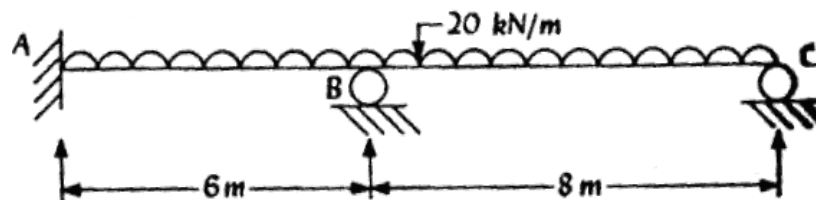
Module V

10. Analyse the continuous beam using slope deflection method (EI is constant).



(14 marks)

11. Analyse the continuous beam in figure using moment distribution method (EI is constant).



(14 marks)

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand	10	10	30
Apply	30	30	60
Analyse	10	10	10
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
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Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

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

Course Level Assessment (Sample) Questions

CO1: Recall the fundamental concepts of limit state design and code provisions for design of concrete members under bending, shear, compression and torsion.

1. Explain the term limit state design.
2. Enumerate the five limit states commonly used in limit state design and state briefly how they are provided for in design.
3. Define the term partial safety factor as used in limit state design. Identify the various factors and state the values recommended in IS 456
4. Explain the term 'factored load' and 'characteristic loads. Why IS 456 specifies the same partial safety factor for dead and live loads? Is it technically correct?
5. How are the following factors incorporated in design formulae for limit design
 - (a) partial safety factor for load,
 - (b) partial safety factor for material strength,

- (c) difference between cube strength and strength of concrete in structure.
6. Explain the basis for the selection of partial load and safety factors by the Code for serviceability limit states
 7. Why is the partial safety factor for concrete (γ_c) greater than that for reinforcing steel (γ_s) in the consideration of ultimate limit states?
 8. Explain the necessity for specifying maximum and minimum tension steel in reinforced beams. What are their values?
 9. What is equivalent shear as applied to torsion and shear in IS 456?
 10. Explain the terms 'balanced', 'over reinforced' and 'under reinforced' section. Explain which of these should be recommended in design. How is this ensured in design of beams according to IS 456?
 11. Why is it necessary to put a limit on the x/d allowed in singly reinforced beams as stipulated in IS 456? Can this condition be relaxed for beams with compression steel? Give reasons for your answer
 12. What are the types of reinforcements used to resist shear? Explain the action of different types of shear steel in resisting shear.
 13. What is meant by equivalent length of a column? Explain how column behaviour is affected by the effective length.
 14. Why is it necessary to have lateral ties in a column?
 15. How do helically reinforced columns differ from tied columns in their behaviour? In what situations would one recommend the use of helically reinforced column?

CO2: Analyse reinforced concrete sections to determine the ultimate capacity in bending, shear and compression.

1.	A rectangular beam 250mm wide and effective depth 450 mm has 4 bars of 20mm diameter. Find the moment of resistance of the section if M20 concrete and Fe 415 grade steel are used. As per IS 456:2000 find the limiting moment of resistance also.
2.	A rectangular RC beam 230 mm wide and 420 mm effective depth is reinforced with 2-16mm diameter bars at top and 4 – 16 mm bars at bottom. Estimate the ultimate moment carrying capacity of the section assuming M20 concrete and Fe415 steel.
3.	A rectangular beam 250mm wide and effective depth 450 mm has 4 bars of 20mm diameter. 8mm diameter two legged vertical stirrups are provided at 200 mm c/c. Determine the ultimate SF the section can resist. Assume M20 concrete and Fe415 steel.
4.	A square column 300 mm x 300 mm is reinforced with 8 bars of 16 mm diameter. Assuming M25 concrete and Fe415 steel, determine the safe axial load carrying capacity of the column

CO3: Design and detail beams, slab, stairs and footings using IS code provisions.

1. Design a simply supported beam of span 6m subjected to a live load of 4 kN/m. Use M20 concrete and Fe415 steel.
2. Design a simply supported rectangular beam to carry a superimposed load of 30kN/m over a span of 5.5m. Assume support width as 300mm. Maximum overall depth is restricted to 550mm. Use M20 concrete and Fe 415 grade steel.
3. Design a slab for a room of size 3mx5.5m carrying a live load of 7 kN/m². Use M20 concrete and Fe 415 grade steel. Assume that the corners are held down. The slab is having all the four edges discontinuous
4. Design a square isolated footing for a column of size 400mm x 400mm carrying a load of 1500 kN under service conditions. Safe bearing capacity of soil is 200 kN/m². Use M20 concrete and Fe 415 grade steel.
5. Design and detail an isolated rectangular footing for a column 400 mm x 600 mm to carry a load of 2000 kN. The SBC of the soil is 180 kN/m². Use M20 concrete and Fe 415 grade steel
6. A dog-legged staircase for a residential flat consists of 18 steps, each of 300 mm tread 180 mm rise, with an intermediate landing 1.2 m in width at the middle. The width of staircase is also 1.2 m. If the flights are of equal number of steps, design the staircase detail the steel. $f_{ck} = 20 \text{ N/mm}^2$ and $f_y = 415 \text{ N/mm}^2$.
7. Explain the design detail of a combined rectangular footing with reinforcement details.

CO4: Design and detail columns using IS code and SP 16 design charts.

1. Design a RCC rectangular column to carry an axial load of 1200 kN and a moment of 70 kNm, The length of the column is 3.5m. The one end is fixed and the other end is hinged. The width of the column is restricted to the wall thickness of 24 cm.
2. Design a reinforced concrete column to carry an axial load of 1600 kN. Use M20 concrete and Fe415 steel. The column has unsupported length of 3m and is effectively held in position at both the ends, but not restrained against rotation.
3. Design and detail a column under biaxial bending with the following data:
 Size of column = 40 x 60cm
 The column is effectively held in position at both ends but not restrained against rotation. The unsupported length of column is 3.5m
 Concrete grade = M20
 Grade of Steel = Fe 415
 Factored load $P_u = 1900 \text{ kN}$
 Factored Moment $M_{ux} = 150 \text{ kNm}$ and $M_{uy} = 110 \text{ kNm}$
4. A short column 300 mm x 600 mm is carrying an axial working load of 750 kN and a moment of 160 kNm at an axis bisecting the depth. Design the reinforcement required if $f_y = 250 \text{ N/mm}^2$ and $f_{ck} = 20 \text{ N/mm}^2$, Also sketch the reinforcement.

CO5: Explain the criteria for earthquake resistant design of structures and ductile detailing of concrete structures subjected to seismic forces.

1. What are the objectives of earthquake-resistant design of reinforced concrete structures?
2. What are the objectives behind the special detailing provisions in IS 13920?
3. Distinguish between ordinary moment resisting frame (OMRF) and special moment resisting frame (SMRF)
4. How do you fix the minimum width of columns of moment resisting frames in Zone III?
5. What are the design requirements of beam-column joints?
6. What is meant by special confining reinforcement in columns of ductile frames?
7. What are the design requirements of beam-column joints in earthquake resistant design?

SYLLABUS

Module I

Introduction – Limit states – Limit state of collapse in flexure – Analysis and design of singly reinforced beams.

Module II

Analysis & design of doubly reinforced beams. Analysis of T-beams . Limit state of collapse in shear. Bond and development length.

Module III

Design of slabs – one way and two way slabs. Design of stair case.

Module IV

Limit state of collapse – compression, Design of axially loaded short column.

Design of short columns subjected to compression and uniaxial/biaxial bending- design using SP16 charts.

Module V

Design of isolated and combined footings.

Limit state of serviceability.

Introduction to earthquake resistant design. Codal provisions – IS 1893, IS 13920

Text Book:

1. Punmia, B. C, Jain A.K and, Jain A.K , R C C Designs, Laxmi Publications Ltd., 10e, 2015

References:

1. Pillai S.U & Menon D – Reinforced Concrete Design, Tata McGraw Hill Book Co., 2009
2. Varghese P.C, Limit State Design of Reinforced Concrete, Prentice Hall of India Pvt Ltd, 2008
4. Relevant IS codes (IS 456, IS 875, IS 1893, IS 13920, SP 16, SP 34)

Lecture Plan –Design of Concrete Structures

Module	Topic	Course Outcomes addressed	No. of Lectures
1	Module I : Total lecture hours : 9		
1.1	Introduction – Principles of Limit state method of design, Introduction to BIS code- Types of limit states-characteristic and design values-partial safety factors-types of loads and their factors.	CO1	2
1.2	Limit State of Collapse by flexure -assumptions-stress-strain relationship of steel and concrete-	CO1	2

1.3	Analysis of singly reinforced rectangular beams-balanced-under reinforced-over reinforced sections-moment of resistance codal provisions	CO2	2
1.4	Design of singly reinforced rectangular beams- basic rules for design-.	CO3	1
1.5	Design example of simply supported beam- design of cantilever beam-detailing	CO3	2
2	Module II : Total lecture hours : 9		
2.1	Analysis of doubly reinforced beams	CO2	1
2.2	Design of doubly reinforced beams –detailing,	CO3	1
2.3	T-beams- terminology- Formulae for analysis of T beams- examples –	CO1,CO2	2
2.4	Limit state of collapse in shear and bond- shear stresses in beams-types of reinforcement-shear strength of RC beam-IS code recommendations for shear design-	CO1	2
2.5	Design of shear reinforcement-examples	CO3	1
2.6	Bond and development length - anchorage for reinforcement bars - code recommendations regarding curtailment of reinforcement	CO1, CO3	1
2.7	Design for torsion-IS code approach- examples	CO3	1
3	Module III : Total lecture hours : 10		
3.1	Design of slabs- introduction- one-way and two-way action of slabs - load distribution in a slab-	CO1,CO3	1
3.2	IS recommendations for design of slabs- design of one-way slab- numerical problems – concepts of detailing of continuous slab –code coefficients.	CO1,CO3	2
3.3	Two- way slabs- simply supported design using IS Code coefficients Reinforcement detailing	CO1,CO3	2
3.4	Two- way slabs- restrained slabs – design using IS Code coefficients Reinforcement detailing	CO1,CO3	2
3.5	Stair cases- Types-proportioning-loads- distribution of loads – codal provisions –Concepts of tread-riser type stairs (detailing only)	CO1,CO3	1
3.6	Design and detailing of dog legged stair-	CO1,CO3	2
4	Module IV : Total lecture hours : 9		
4.4	Columns- introduction –classification- effective length-short column - long column - reinforcement-IS specifications regarding columns- limit state of collapse: compression -	CO1,CO4	1
4.5	Design of axially loaded short columns-design examples	CO4	2

	with rectangular ties		
4.6	Design of axially loaded short columns-design examples with helical reinforcement	CO4	2
5.1	Analysis and design of short columns subjected to compression and uniaxial bending- design using SP16 charts for limit state	CO4	2
5.2	Analysis and design of short columns subjected to combined axial load and biaxial bending moments-code procedure for design- design using SP16 charts for limit state	CO2,CO4	2
5	Module V : Total lecture hours : 11		
5.3	Foundations- classification-IS code provisions for design of isolated footings-	CO1, CO3	2
5.4	Design principles of rectangular footings- detailing.	CO1, CO3	2
5.5	Combined footings (design principles only)- analysis of combined footings-rectangular and trapezoidal.	CO1, CO3	2
4.1	Limit state of serviceability - limit state of deflection- short term and long term deflection-	CO1	1
4.2	Limit state of serviceability - IS code recommendations- limit state of cracking- estimation of crack width- simple numerical examples	CO1	2
4.3	Introduction to earthquake resistant design, Importance of Ductility in Seismic Design, Major Design Considerations, Codal provisions – IS 1893, IS 13920	CO5	2

MODEL QUESTION PAPER

Reg. No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CET303

Course Name: Design of Concrete Structures

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions; each question carries 3 marks.

1.
 - a) Derive the limiting values of depth of neutral axis for different grades of steel
 - b) Define characteristic strength & partial safety factor for materials. Why is partial safety factor for material high for concrete than steel?
 - c) Explain the term development length and explain its significance in RC design. obtain the expression for it
 - d) Explain why and how shear reinforcement is provided in beams
 - e) Explain the difference in the behaviour of one-way and two-way slabs. Why it is essential to provide corner reinforcement in two way rectangular slabs whose corners are prevented from lifting up?
 - f) What is meant by stair supported on landings? Explain the codal provision for the effective span of the stair slab in such cases?
 - g) What are the objectives behind the special detailing provisions in IS 13920?
 - h) Compare the behaviour of tied columns with spiral column subject to axial loading.
 - i) Explain how interaction curves are used in the design of column
 - j) Explain at what situations a combined footing is recommended.

(10×3 marks = 30 marks)

PART B

Answer one full question from each module; each full question carries 14 marks.

Module I

2.
 - (a) Explain balanced, under reinforced and over reinforced sections in the context of Limit State Design of Reinforced Concrete structures. **(4 marks)**
 - (b) A rectangular beam 250mm wide and effective depth 450 mm has 4 bars of 20mm diameter. Find the moment of resistance of the section if M20 concrete and Fe 415 grade steel are used. As per IS 456:2000 find the limiting moment of resistance also. **(10 marks)**
3.
 - (a) Explain the term Limit State. Enumerate the different limit states to be considered in reinforced concrete design. **(4 marks)**
 - (b).Design and detail an RC rectangular section subjected to a udl of 15 kN/m over the entire span. Clear span is 5m. The beam is supported on masonry walls, 230 mm thick on

both sides. Assume moderate exposure conditions. Use M 25 grade concrete and Fe 415 grade steel.(10 marks)

Module II

4. (a) Enumerate the situations in which a doubly reinforced section become necessary. Derive expression for the ultimate moment of resistance of doubly reinforced section Explain. (4 marks)
- (b) Determine the ultimate moment of resistance of a doubly reinforced rectangular section of width 300 mm and overall depth 700 mm reinforced with 4 – 25mm diameter bars on tension side and 2 – 25mm diameter bars on compression side. Assume effective cover of 45 mm on both sides. Use M 20 concrete and Fe 415 steel.(10 marks)
5. (a) The provision of minimum stirrup reinforcement is mandatory in all reinforced concrete beams. Why?(2 marks)
- (b) Determine the ultimate moment of resistance of an isolated beam of T-shaped cross-section having a span of 6m and cross sectional dimensions are flange width of 1000mm, flange thickness of 100mm, web width of 250mm and an effective depth of 520mm, having tension reinforcement of 6 x 28mm diameter bars. The materials used are concrete mix of grade M20 and mild steel of grade Fe 415. (12 marks)

Module III

6. (a) Distinguish between one way slab and two way slab. (2 marks)
- (b) Design and detail a simply supported slab for a room of interior dimension 5m x 4m subjected to an imposed load of 8 kN/m². Thickness of supporting wall is 230 mm. Use M 20 concrete and Fe 415 grade steel.(12 marks)
7. (a) Explain the behavior of two way slabs and also the need of corner reinforcement in two way rectangular slabs whose corners are prevented from lifting.(3 marks)
- (b) Design a staircase to be provided in a residential building in two straight opposite flights of 1.0m width connected by a landing for a floor height of 3.3m. The landing which is 1m wide spans in the same direction as the stair slab. The rise and tread shall be 150mm and 270mm respectively. The weight of finishes 1kN/m², live load =3kN/m². M20 concrete & Fe415 steel are to be used.(11 marks)

Module IV

8. (a)Classify the columns separately based on loadings and slenderness ratios.(4 marks)
- b)Design a reinforced concrete column to carry an axial load of 1600 kN. Use M20 concrete and Fe415 steel. The column has unsupported length of 3m and is effectively held in position at both the ends, but not restrained against rotation.(10 marks)
9. a)Draw four typical strain profiles of a short, rectangular and symmetrically reinforced concrete column causing collapse subjected to different pairs of P_u and M_u when the depths of the neutral axis are (i) less than the depth of column D , (ii) equal to the depth of column D , (iii) $D < x_u < \infty$ and (iv) $x_u = \infty$. Explain the behaviour of column for each of the four strain profiles. (4 marks)

(b) Design a RCC rectangular column to carry an axial load of 1200 kN and a moment of 70 kNm, The length of the column is 3.5m. The one end is fixed and the other end is hinged. The width of the column is restricted to the wall thickness of 24 cm.(10 marks)

Module V

10. (a) Design a footing for a 400 mm x 400 mm column to carry a load of 100 kN with foundation resting on a soil of SBC 120 kN/m². Assume M20 concrete and Fe415 steel. (8 marks)
- (b) What are the objectives of earthquake-resistant design of reinforced concrete structures? What are the design requirements of beam-column joints in earthquake resistant design? (6 marks)
11. (a) Explain the different types of shallow footings.(2 marks)
- (b) Design an isolated rectangular footing for a column 450 mm x 600 mm to carry a load of 2400 kN. The SBC of the soil is 180 kN/m². Use M20 concrete and Fe 415 grade steel. (10 marks)

CET 305	GEOTECHNICAL ENGINEERING - II	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	4	0	0	4	2019

Preamble: Goal of this course is to impart to the students, in-depth knowledge about the basic concepts and theories of foundation engineering. After this course, students will be able to recognize practical problems of foundations in real-world situations and respond accordingly.

Prerequisite : Geotechnical Engineering - I

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

CO 1	Understand soil exploration methods
CO 2	Explain the basic concepts, theories and methods of analysis in foundation engineering
CO 3	Calculate bearing capacity, pile capacity, foundation settlement and earth pressure
CO 4	Analyze shallow and deep foundations
CO 5	Solve the field problems related to geotechnical engineering

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	5	5	10
Understand	10	10	20
Apply	25	25	50
Analyse	10	10	20
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation (CIE)Pattern :

Attendance	: 10 Marks
Continuous Assessment Test (2 numbers)	: 25 Marks
Assignment/Quiz/Course project	: 15 Marks

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

Course Level Assessment Questions

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

Course Outcome 1 (CO1):

1. Understand Soil Investigation and Soil Exploration methods

Course Outcome 2 (CO2):

1. Explain the bearing capacity theory of shallow foundations
2. Explain the basic concepts and theory of settlement calculations of shallow foundations
3. Explain the concepts and theory of pile capacity
4. Explain the earth pressure theories for cohesionless and cohesive soils

Course Outcome 3 (CO3):

1. Calculate the bearing capacity of shallow foundations
2. Calculate pile capacity
3. Calculate the settlement of footings
4. Calculate the earth pressure acting on retaining walls

Course Outcome 4 (CO4):

1. Analyze and design shallow foundations
2. Analyze deep foundations

Course Outcome 5 (CO5):

1. Solve the field problems related to different types of shallow and deep foundations, retaining walls, etc.

SYLLABUS

Module 1

Earth pressure : Earth pressure - At rest, active and passive earth pressures - Practical examples Rankine's theory – Earth pressure and point of application for cohesionless and cohesive soils - Influence of surcharge and water table on earth pressure - Numerical problems - Earth pressure with layered backfill - Numerical problems - Coulomb's theory [no derivation required] – Comparison of Rankine's and Coulomb's theory

Foundation – General Considerations : Functions of foundations - definition of shallow and deep foundation - Selection of type of foundation - Different types of shallow foundations - advantages and limitations of various types of shallow foundations

Module 2

Bearing capacity of shallow foundations: Gross and Net bearing pressure - Ultimate and Safe bearing capacity - Failure mechanism - Allowable soil pressure - Terzaghi's bearing capacity theory for strip footing [no derivation required] – Assumptions – Bearing capacity factors - Numerical problems - Terzaghi's formulae for circular and square footings - Numerical problems - Factors affecting bearing capacity - Effect of water table on bearing capacity - Numerical problems - General, local and punching shear failure - Skempton's formula – Numerical problems

Module 3

Settlement analysis: Introduction- causes of settlement – estimation of immediate settlement – Numerical problems - Allowable settlement-Maximum and differential settlements as per Indian standard - Field test - Plate load test – Procedure, uses and limitations

Footings :Principles of design of footings – strip/continuous and individual footings - Numerical Problems - Combined footings- Rectangular and Trapezoidal combined footings - Numerical problems - Footings subjected to eccentric loading

Raft foundations: Types – Principles of design of raft foundation- Bearing capacity equations for raft on sand (Teng's equation based on SPT value) and for raft on clay (Skempton's formula) - Floating foundations - conventional design procedure for rigid mat.

Module 4

Pile foundations: uses of piles - classification of piles - determination of type and length of piles - Bearing capacity of single pile in clay and sand [I.S. Static formulae] - Numerical problems - Dynamic formulae (Modified Hiley formulae only) – Numerical Problems - I.S. Pile load test [conventional] - Negative skin friction - Group action - Group efficiency - Capacity of Pile groups - Numerical problems

Well foundation : Elements of a well foundation – construction details of well foundations - Problems encountered in well sinking – Methods to rectify tilts and shifts

Module 5

Site investigation and soil exploration: objectives - planning - reconnaissance - Guidelines for choosing spacing and depth of borings [I.S. guidelines only]- Methods of subsurface exploration - test pits - Auger borings – Wash Boring - Rotary drilling - Standard Penetration Test – procedure and correlations - Corrections for SPT value – Numerical Problems - Sampling - disturbed samples, undisturbed samples and chunk samples - types of samplers - Sampler parameters - Boring log - Soil

profile- Location of Water table - Geophysical methods : Seismic Refraction method and Electrical Resistivity method (in brief).

Text Books:

1. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.
2. Arora K. R., Geotechnical Engineering, Standard Publishers, 2006.

References:

1. Das B. M., Principles of Geotechnical Engineering, Cengage India Pvt. Ltd., 2010.
2. Venkatramaiah, Geotechnical Engg, Universities Press, 2000.
3. Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967.
4. A V Narasimha Rao and C Venkatramaiah, Numerical Problems, Examples and Objective questions in Geotechnical Engineering, Universities Press (India) Ltd., 2000
5. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Indersley(India) Pvt. Ltd., 2013
6. Taylor D.W., Fundamentals of Soil Mechanics, Asia Publishing House, 1948.

Course Contents and Lecture Schedule:

Module	Contents	Outcomes Addressed	Hours
1	Module 1		9
1.1	Earth pressure : Earth pressure - At rest, active and passive earth pressures - Practical examples	CO 2 & CO 5	1
1.2	Rankine’s theory – Earth pressure and point of application for cohesionless and cohesive soils	CO 2	1
1.3	Influence of surcharge and water table on earth pressure - Numerical problems	CO 2 & CO 3	2
1.4	Earth pressure with layered backfill - Numerical problems	CO 2 & CO 3	2
1.5	Coulomb’s theory [no derivation required] – Comparison of Rankine’s and Coulomb’s theory	CO 2	1
1.6	Foundation – General Considerations: Functions of foundations - definition of shallow and deep foundation - Selection of type of foundation	CO 4 & CO 5	1
1.7	Different types of shallow foundations- advantages and limitations of various types of shallow foundations	CO 4 & CO 5	1
2	Module 2		9
2.1	Bearing capacity of shallow foundations: Gross and Net bearing pressure - Ultimate and Safe bearing capacity	CO 2	1
2.2	Failure mechanism - Allowable soil pressure	CO 2	1

2.3	Terzaghi's bearing capacity theory for strip footing [no derivation required] – Assumptions – Bearing capacity factors	CO 2	1
2.4	Numerical problems	CO 3	1
2.5	Terzaghi's formulae for circular and square footings - Numerical problems	CO 2 & CO 3	1
2.6	Factors affecting bearing capacity - Effect of water table on bearing capacity	CO 2	1
2.7	Numerical problems	CO 3	1
2.8	General, local and punching shear failure	CO 2 & CO 3	1
2.9	Skempton's formula – Numerical problems	CO 2 & CO 3	1
3	Module 3		9
3.1	Settlement analysis: Introduction- causes of settlement – estimation of immediate settlement – Numerical problems	CO 2 & CO 3	1
3.2	Allowable settlement-Maximum and differential settlements as per Indian standard	CO 2 & CO 5	1
3.3	Field test - Plate load test – Procedure, uses and limitations	CO 3 & CO 5	1
3.4	Footings :Principles of design of footings – strip/continuous and individual footings - Numerical Problems	CO 4	1
3.5	Combined footings- Rectangular and Trapezoidal combined footings	CO 4	1
3.6	Numerical problems	CO 4	1
3.7	Footings subjected to eccentric loading	CO 4	1
3.8	Raft foundations: Types – Principles of design of raft foundation- Bearing capacity equations for raft on sand (Teng's equation based on SPT value) and for raft on clay (Skempton's formula)	CO 3 & CO 4	1
3.9	Floating foundations - conventional design procedure for rigid mat.	CO 2 & CO 4	1
4	Module 4		9
4.1	Pile foundations: Uses of piles - classification of piles - determination of type and length of piles	CO 2 & CO 5	1
4.2	Bearing capacity of single pile in clay and sand [I.S. Static formulae]	CO 2	1
4.3	Numerical problems	CO 3	1
4.4	Dynamic formulae (Modified Hiley formulae only) – Numerical Problems	CO 2 & CO 3	1
4.5	I.S. Pile load test [conventional]	CO 5	1
4.6	Negative skin friction - Group action - Group efficiency	CO 2	1
4.7	Capacity of Pile groups - Numerical problems	CO 3 & CO 4	1
4.8	Well foundation : Elements of a well foundation – construction details of well foundations	CO 2 & CO 5	1

4.9	Problems encountered in well sinking – Methods to rectify tilts and shifts	CO 2 & CO 5	1
5	Module 5		9
5.1	Site investigation and soil exploration: objectives - planning - reconnaissance	CO 1	1
5.2	Guidelines for choosing spacing and depth of borings [I.S. guidelines only]	CO 1	1
5.3	methods of subsurface exploration - test pits - Auger borings – Wash Boring - Rotary drilling	CO 1	1
5.4	Standard Penetration Test – procedure and correlations	CO 1	1
5.5	Corrections for SPT value – Numerical Problems	CO 1	1
5.6	Sampling - disturbed samples, undisturbed samples and chunk samples	CO 1	1
5.7	types of samplers - Sampler parameters	CO 1	1
5.8	Boring log - soil profile- Location of Water table	CO 1	
5.9	Geophysical methods: Seismic Refraction method and Electrical Resistivity method (in brief).	CO 1	1

Model Question Paper

QP CODE:

Reg No.: _____

Name: _____

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

Course Code: CET305

Course Name :GEOTECHNICAL ENGINEERING - II

Max. Marks: 100

Duration: 3 hours

Part A

(Answer all questions; each question carries 3 marks)

1. List the assumptions of Rankine's theory of earth pressure.
2. Explain the situations in which combined footings are provided.
3. Write the assumptions of Terzaghi's method for bearing capacity.
4. Explain the factors affecting bearing capacity.
5. Explain Allowable settlement.
6. Explain floating foundation.
7. Explain negative skin friction.
8. List the elements of a well foundation.
9. List Objectives of soil exploration.
10. Define (i) Inside clearance, (ii) Outside clearance and (iii) Area ratio as applied to sampler.

PART B

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

Module – 1

17. (a) Explain different types of earth pressures with practical examples. (6 Marks)
(b) A wall of 8m height retains a non-cohesive layered backfill. Top 3 m soil is having $\gamma = 18\text{kN/m}^3$ and $\phi = 30^\circ$. Bottom 5 m soil is having $\gamma = 17.5\text{ kN/m}^3$ and $\phi = 28^\circ$. Using Rankine's theory, find the total active thrust on the wall and the point of application. (8 Marks)
18. (a) A 6m high retaining wall with vertical back supports soil which is in level with the top of retaining wall carries a uniform surcharge load of 20kPa. Backfill properties are $c = 5\text{ kN/m}^2$, $\gamma = 18.5\text{ kN/m}^3$, $\phi = 30^\circ$. Determine Rankine's passive earth pressure on the retaining wall. (6 Marks)
(b) A 6m high retaining wall with vertical back supports soil which is in level with the top of retaining wall. Backfill properties are $c = 5\text{ kN/m}^2$, $\gamma = 18\text{ kN/m}^3$, $\phi = 30^\circ$. Find the maximum depth up to which excavation can safely be done without the sides caving in? Also determine Rankine's active earth pressure on the retaining wall before the formation of tension crack. (8 Marks)

Module – 2

11. (a) Differentiate between General shear failure and local shear failure. (6 Marks)
- (b) A strip footing of 2.0 m wide is to be founded at a depth of 1.6 m in a soil with following data:
 $\gamma = 19 \text{ kN/m}^3$; $c = 10 \text{ kN/m}^2$; $\phi = 40^\circ$
 $N_c = 95.7$; $N_q = 81.3$; $N_\gamma = 100.4$
- Determine the safe bearing capacity with a FS of 3, when
- Water table is at great depth
 - Water table is at a depth of 1.0 m from ground level.
 - Water table is at a depth of 3.0 m from ground level. (8 Marks)
12. (a) A Circular footing rests in pure clay with unconfined compressive strength $q_u = 200 \text{ kN/m}^2$ at a depth of 1.5 m. Using Skempton's method, determine the diameter of footing if it has to transmit a net load of 1000 kN. Take FS = 3. (6 Marks)
- (b) A square footing 2m x 2m is at a depth of 1.5 m in a soil with $c = 30 \text{ kN/m}^2$, $\phi = 35^\circ$, ($N_c = 57.8$, $N_q = 41.4$ and $N_\gamma = 42.4$). Take $\gamma = 18 \text{ kN/m}^3$. Calculate the net safe load that can be carried by footing. (8 Marks)

Module – 3

13. (a) A rectangular surface footing 2m x 3m carries a column load of 600 kN. The footing rests on a $c-\phi$ soil strata 6 m thick having $\mu = 0.25$ and E as 5000 kN/m^2 . Calculate the immediate settlement of footing assuming the influence factor $I_f = 1.36$. (6 Marks)
- (b) Explain Plate Load Test with neat sketch. List the limitations of plate load test. (8 Marks)
16. (a) What are the different types of raft foundations? Under what circumstances raft foundations are preferred? (6 Marks)
- (b) Design a rectangular combined footing for uniform pressure for the column loads of 1000 kN and 1500 kN at column A and B respectively. Projection of footing beyond centre line of column A is restricted to 0.5 m. Distance of c/c of columns is 5 m. Net Allowable pressure = 150 kN/m^2 .
- Design a suitable combined footing if projection beyond centre line of both columns restricted to 0.5 m. (8 Marks)

Module – 4

19. (a) Explain the classification of pile foundations based on installation. (6 Marks)
- (b) A RCC pile weighs 25 kN is driven by drop hammer weighing 35 kN, having effective fall of 0.85 m. Average set/blow is 1.3 cm. Take elastic compression as 1.6 cm. Assuming coefficient of restitution as 0.25. Find ultimate and safe load on pile by assuming factor of safety of 2.5. (8 Marks)
20. (a) Explain any three methods (with neat sketches) for rectification of tilts in a well foundation. (6 Marks)
- (b) A bored pile in a clayey soil is 50 cm diameter and 10 m long, determine the capacity of a 3X3

pile group spaced 1 m centre to centre both ways. Take $C_u = 70 \text{ kN/m}^2$ and $\alpha = 0.6$.

(8 Marks)

Module – 5

14. (a) Explain Augur boring and wash boring methods used in soil exploration. (6 Marks)
- (b) Explain Standard Penetration Test? How this is correlated with shear strength parameters? What are the corrections to the observed SPT (N) value? (8 Marks)
15. (a) A SPT is conducted in a sand deposit at a depth of 16 m. Water table is at 7 m below ground level. Unit weight of sand is 18 kN/m^3 above water table and 19 kN/m^3 below water table. If N value is 36, find the corrected N value. (6 Marks)
- (b) Explain Geophysical Exploration using Seismic Refraction Method. What are its limitations? (8 Marks)

CET 307	HYDROLOGY & WATER RESOURCES ENGINEERING	Category	L	T	P	Credit	Year of Introduction
		PCC	4	0	0	4	2019

Preamble: The general objective of this course is to expose the students to the fundamental concepts of surface and groundwater components of hydrology and basics of water resources engineering. The course aim to impart the knowledge on the availability of water on hydrosphere, its distribution and quantification, scientific methods for computing irrigation water requirements, reservoir engineering and river engineering

Pre-requisite: NIL

Course outcome

After the course, the student will be able to:

CO1	Describe and estimate the different components of hydrologic cycle by processing hydro-meteorological data
CO2	Determine the crop water requirements for the design of irrigation canals by recollecting the principles of irrigation engineering
CO3	Perform the estimation of streamflow and/or describe the river behavior and control structures
CO4	Describe and apply the principles of reservoir engineering to estimate the capacity of reservoirs and their useful life
CO5	Demonstrate the principles of groundwater engineering and apply them for computing the yield of aquifers and wells

CO - PO Mapping

CET307 Hydrology and Water Resources		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	CO1	3	3		1			1					
	CO2	3	3					1					
	CO3	3	2					1					
	CO4	3	3					1					
	CO5	3	3					1					

Assessment pattern

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

Continuous Internal Evaluation Pattern:

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course project	:	15 marks
Total	:	50 marks

End semester examination pattern – There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code: CET 307
Hydrology and Water Resources Engineering
(Course Level Assessment Questions)

CO1	Describe and estimate the different components of hydrologic cycle by processing hydro-meteorological data
1	Differentiate rainfall mass curve and hyetograph
2	Explain the use of double ring infiltration for infiltration measurement
3	Explain any three methods for baseflow separation
4	Explain the limitations of unit hydrograph theory
5	A storm with 10 cm of precipitation produced a direct runoff of 5.8 cm. The duration of the rainfall was 16 hrs and its time distribution is given below : (10 Marks)

	Time from start (h)	0	2	4	6	8	10	12	14	16				
	Cumulative rainfall (cm)	0	0.4	1.3	2.8	5.1	6.9	8.5	9.5	10				
Determine the ϕ -index of the storm.														
6	The ordinates of a 4-hour unit hydrograph for a particular basin are given below. Determine the ordinates of the 6-hour unit hydrograph.													
	Time (hrs)	0	2	4	6	8	10	12	14	16	18	20	22	24
	Discharge (Cumecs)	0	25	100	160	190	170	110	70	30	20	16	1.5	0

CO2	Determine the crop water requirements for the design of irrigation canals by recollecting the principles of irrigation engineering
1	Explain the factors affecting duty. Explain how can you improve the duty
2	Define duty and delta. Obtain the relation between the two
3	Define the different types of irrigation efficiencies
4	The following data pertaining to healthy growth of a crop: Root zone depth = 75 cm Field capacity = 27 %, Wilting point=14 % Dry density of soil=1500 kg/m ³ . Daily consumptive use =11 mm. Assuming 80 % depletion of available moisture as an indicator for application of water, determine how long the crop survive without irrigation
5	The CCA for a distributary is 15000 ha. The intensity of irrigation for Rabi is 40 % and for Kharif is 15 %. If the total water requirement of the two crops is 37.5 cm and 120 cm and their periods of growth are 160 days and 140 days respectively, determine the design discharge at the outlet.

CO3	Perform the estimation of streamflow and/or describe the river behavior and control structures												
1	Explain Meandering. What are the causes of meandering ?												
2	Explain the objectives of providing river training works												
3	Enlist the factors affecting the selection of site for stream gauging station												
4	The data pertaining to a stream gauging operation at a gauging station are given below. The rating equation of the current meter is $v = 0.32N_s + 0.032$ m/sec where N_s is the number of revolutions per second. Compute the discharge in the stream by area velocity method												
	Distance from left water edge (m)	0	2	4	6	9	12	15	18	20	22	23	24
	Depth (m)	0	0.5	1.1	1.95	2.25	1.85	1.75	1.65	1.5	1.25	0.75	0
	Revolutions of current meter kept at 0.6 depth	0	80	83	131	139	121	114	109	92	85	70	0
	Duration of observation (s)	0	180	120	120	120	120	120	120	120	120	120	120
5	Describe with sketches different type of groynes												

CO4	Describe and apply the principles of reservoir engineering to estimate the capacity of reservoirs and their useful life												
1	Define safe yield, secondary yield and design yield of reservoirs												
2	Explain mass inflow curve and mass demand curve												
3	Explain with a neat sketch the zones of a storage reservoir												
4	Explain the procedure for estimating the life of storage reservoir												

5	The average annual discharge of a river for 11 years is given below											
	Year	1960	61	62	63	64	65	66	67	68	69	70
	Discharge (m ³ /sec)	1750	2650	3010	2240	2630	3200	1000	950	1200	4150	3500
Determine the storage capacity of a reservoir required to meet a demand of 2000 cumec throughout the year by mass curve method.												

CO5	Demonstrate the principles of groundwater engineering and apply them for computing the yield of aquifers and wells
1	State Darcy's law and its limitations
2	Enlist the assumptions in the derivation of Dupuit's equation
3	Differentiate perched aquifer and leaky aquifer
4	Describe the working of strainer type tube well with a sketch
5	Pumping at the rate of 1500 litres per minute from a 30cm diameter well of depth 60m in an unconfined aquifer gives a drawdown of 2m and 1.1m in observation wells located at distances 120m and 160m respectively from it. Calculate the drawdown of the pumping well and the coefficient of permeability of the aquifer.
6	During a recuperation test conducted on an open well in a region, the water level in the well was depressed by 3 m and it was observed to rise by 1.75 m in 75 minutes. (a) What is the specific yield of open wells in that region (b) What will be the yield from a well of 5 m diameter under a depression head of 2.5 m ? (c) What diameter should be the diameter of the well to give a yield of 12 l/sec under a depression head of 2 m ?

Course Code: CET 307
Hydrology and Water Resources Engineering
Syllabus

Module I

Hydrologic cycle-precipitation-mechanism, types, forms and measurement using rain gauges ; Optimum number of rain gauges, representation of rainfall data-mass curve and hyetograph, computation of mean precipitation over a catchment, Design rainfall - probable maximum rainfall; IDF curves (conceptual idea only). Infiltration-measurement by double ring infiltrometer, Horton's model, infiltration indices. Evaporation –measurement and control

Module II

Runoff-components of runoff- Hydrograph analysis-Hydrograph from isolated storm-Base flow separation. Unit hydrograph – uses, assumptions and limitations of unit hydrograph theory. Computation of storm/flood hydrograph of different duration by method of superposition and by development of S– Hydrograph; Floods-methods of design flood estimation –Empirical methods; SPF and PMF, Return period (conceptual ideas only)

Module III

Irrigation– Necessity, Benefits and ill effects. Types: flow and lift irrigation - perennial and inundation irrigation. Soil-water –plant relationships. Irrigation efficiencies, Computation of crop water requirement: depth and frequency of Irrigation. Duty and delta, duty-factors affecting and method of improving duty, Computation of crop water requirement by using the concept of duty and delta

Module IV

Streamflow measurement-area velocity method of stream gauging, selection of site for stream gauging station, Stage-discharge curve, flow duration curve-uses and characteristics. River training works-types; Meandering and meander parameters; Reservoirs- types, zones, yield of reservoir; determination of storage capacity and yield by mass curve method; Reservoir sedimentation and control- trap efficiency- computation of life of reservoir

Module V

Vertical distribution of ground water- classification of saturated formation (review) Aquifer properties, Darcy's law, Well hydraulics-Steady radial flow into a fully penetrating well in Confined and Unconfined aquifers; Types of wells, Types of tube wells; well losses; Yield of open wells-pumping test and recuperation test

Text Books:

1. Modi P. N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors New Delhi 2009.
2. Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd. 2009

References:

3. VenTe Chow. Hand book of Applied Hydrology, Tata McGraw Hill, 1988
4. Todd D. K. Ground Water Hydrology, Wiley, 2005.
5. H.M Raghunath. Groundwater. New Age International New Delhi 2007
6. G.L.Asawa. Irrigation and Water Resources Engineering New Age International New Delhi 2008
7. Garg S. K. Hydrology and Water Resources Engineering, Khanna Publishers New Delhi 2005.
8. Garg SK, Irrigation Engineering and Hydraulic Structures Khanna Publishers New Delhi 2006.
9. Subramanya K. Engineering Hydrology, Tata McGraw Hill, 2013.
10. Raghunath H.M. Hydrology: Principles, Analysis and Design. New Age International New Delhi 2006.

Course Code: CET 307
Hydrology and Water Resources Engineering
(Course plan)

Module	Topic	Course outcome addressed	No of Hours
Module I (11 Hours)			
1.1	Hydrology-Hydrologic cycle	CO1	1
1.2	Precipitation- mechanism, types, forms	CO1	1
1.3	Measurements of rainfall- Use of rain gauges	CO1	1
1.4	Representation of rainfall data-Rainfall Mass curve, hyetograph; Optimum number of rain gauges	CO1	1
1.5	Estimation of missing precipitation	CO1	1
1.6	Computation of mean precipitation	CO1	1
1.7, 1.8	Problems	CO1	2
1.9	Design rainfall - probable maximum rainfall; IDF curves	CO1	1

	(conceptual idea only).		
1.10	Water losses-Infiltration-measurement by double ring infiltrometer, Horton's equation; concept of infiltration indices	CO1	1
1.11	Evaporation-measurement by IMD land pan, control of evaporation	CO1	1
Module II (9 Hours)			
2.1	Runoff- Components, factors affecting runoff, Computation of runoff by different methods.	CO1	1
2.2	Runoff computation by rational formula and from infiltration indices	CO1	1
2.3	Hydrograph analysis-Hydrograph from isolated storm-Base flow separation	CO1	1
2.4	Concept of unit hydrograph-assumptions, uses, applications	CO1	1
2.5	Computation of storm/flood hydrograph ordinates of different duration by method of superposition	CO1	1
2.6	Computation of storm/flood hydrograph ordinates of different duration by development of S– Hydrograph	CO1	1
2.7,2.8	Problems	CO1	2
2.9	Floods-methods of design flood estimation –Empirical methods; SPF and PMF, Return period (conceptual ideas only)	CO1	1
Module III (7 Hours)			
3.1	Irrigation-Benefits and ill effects, lift and flow irrigation	CO2	1
3.2	Types of irrigation, Irrigation efficiencies	CO2	1
3.3	Soil water plant relationships	CO2	1
3.4	Computation of crop water requirement: depth and frequency of Irrigation	CO2	1
3.5	Duty and delta-Factors affecting and method of improving duty	CO2	1
3.6	Estimation of crop water requirement by using the concepts of duty and delta	CO2	1
3.7	Problems	CO2	1
Module IV (11 Hours)			
4.1	Streamflow measurement- measurement of stage and velocity	CO3	1
4.2	Stage-discharge curve- Selection of site for stream gauging station,	CO3	1
4.3	Computation of discharge (Area-velocity method)-problem	CO3	1
4.4	Flow duration curves-uses and characteristics	CO3	1
4.5	River behavior-meandering-meander parameters, Objectives of river training	CO3	1
4.6	Types of river training works	CO3	1

4.7	Reservoirs- types, zones, yield of reservoir	CO4	1
4.8	Storage capacity and yield-by mass curve method	CO4	1
4.9	Reservoir sedimentation-control of sedimentation, trap efficiency	CO4	1
4.10	Useful life of reservoir-computation.	CO4	1
4.11	Problems	CO4	1
Module V (7 Hours)			
5.1	Vertical distribution of ground water - classification of saturated formation (Review)	CO5	1
5.2	Aquifer properties- Darcy's law	CO5	1
5.3	Steady radial flow to a well-unconfined aquifers	CO5	1
5.4	Steady radial flow to a well-unconfined aquifers	CO5	1
5.5	Problems	CO5	1
5.6	Types of wells-open wells and tube well, Types of tube wells - description	CO5	1
5.7	Estimation of yield of an open well- pumping test and recuperation test	CO5	1

Pages: 3

Model Question Paper

Reg No.:.....

QP

CODE:.....

Name:.....

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

Course Code: CET 307

Hydrology and Water Resources Engineering

**Max. Marks: 100
hours**

Duration: 3

Part A

(Answer all questions; each question carries 3 marks)

1. Explain the different forms of precipitation
2. What are the methods of control of evaporation from water bodies?
3. Define unit hydrograph. Explain its uses
4. State the limitations of rational formula for runoff estimation
5. Explain irrigation efficiencies
6. Define duty and delta. Obtain the relation between the two
7. Enlist the factors to be considered in the selection of site for a stream gauging station
8. Explain meandering of rivers
9. Define (i) Storativity (ii) Transmissibility
10. Explain well losses

Part B

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

Module I

- 11 (a) Explain the working of a Siphon type rain gauge with a neat sketch (5 Marks)

- (b) The average rainfall of 5 rain gauge stations in the base stations are 89, 54, 45, 41 and 55 cm. If the error in the estimation rainfall should not exceed 10 %, how many additional gauges may be required to be installed in the catchment? (9 Marks)

OR

- 12.(a) Compare different methods for determination of mean precipitation from a catchment (6 Marks)
- (b) Explain the use of double ring infiltrometer for the measurement of infiltration. How will you develop Horton's model? (8 Marks)

Module II

- 13.(a) The rates of rainfall for the successive 30 min period of a 3-hour storm are:1.6, 3.6, 5.0, 2.8, 2.2, 1.0 cm/hr. The corresponding surface runoff is estimated to be 3.6 cm. Estimate the ϕ -index (7 Marks)
- (b) Explain the characteristics of a single peak hydrograph from an isolated storm. How will you separate the base flow? (7 Marks)

OR

14. Find out the ordinates of a storm hydrograph resulting from a 9 hr storm with rainfall of 2, 5.75 and 2.75 cm during subsequent 3 hr intervals. The ordinates of 3hr unit hydrograph at 3 hr intervals are 0, 100, 355, 510, 380, 300, 260, 225,165, 120,85, 55,30, 22, 10, 0 (cumecs). Assume an initial loss of 0.5 cm and ϕ -index of 2.5 mm/hr and abase flow of 10 cumecs. (14 Marks)

Module III

15. (a) Differentiate lift irrigation and flow irrigation. (4 Marks)
- (b) Estimate the frequency of irrigation required for certain crop for the following data: Root zone depth = 90 cm Field capacity = 22 %, Wilting point=12 % Dry density of soil=1500 kg/m³. Daily Consumptive use =22 mm. Assume 70 % depletion of available moisture as an indicator for application of water (10 Marks)

OR

16. (a) Explain the benefits and ill effects of irrigation (4 Marks)

(b) What are the factors affecting duty? How can you improve the duty of water.

(10 Marks)

Module IV

17 (a) Explain the use of current meter for velocity measurement in streams (7 Marks)

(b) Explain the method of determination of useful life of a reservoir. (7 Marks)

OR

18 (a) Explain the features of different types of groynes (8 Marks)

(b) Explain the types of storage reservoirs (6 Marks)

Module V

19 (a) State Darcy's law and its limitations (4 Marks)

(b) The following observations were recorded during a pumping out test on a tube well penetrating fully in an aquifer: Well diameter: 25 cm, Discharge from the well: 300 m³/hr, RL of original water surface before pumping started: 122.000, RL of water in the well at constant pumping: 117.100, RL of water in the observation well: 121.300, RL of impervious layer: 92.000, radial distance of observation well from the tube well: 50 m. Determine : (a) field permeability coefficient of the aquifer (b) radius of zero drawdown. (10 Marks)

OR

20.(a) Explain the method of determination of yield of an open well (7 Marks)

(b) Explain the working of a strainer type tube well with a sketch (7 Marks)

CET309	CONSTRUCTION TECHNOLOGY AND MANAGEMENT	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	3	0	0	3	2019

Preamble:

Construction Technology and Management introduces the basic concepts of civil engineering construction and its management. The course provides a detailed insight into the materials used in construction, various building elements and construction technology. Management is essential for successful completion of construction projects and the course introduces the students to the basic concepts of construction project management and planning. After the course, students will be familiar with the fundamental concepts of building construction and management.

Prerequisite: Basics of Civil and Mechanical Engineering

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	Describe the properties of materials used in construction	Understand
CO2	Explain the properties of concrete and its determination	Understand
CO3	Describe the various elements of building construction	Understand
CO4	Explain the technologies for construction	Understand
CO5	Describe the procedure for planning and executing public works	Understand
CO6	Apply scheduling techniques in project planning and control	Application

Mapping of course outcomes with program outcomes(Minimum requirement)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					1	1	1		1		1
CO2	3					1		1		1		1
CO3	3					1				1		1
CO4	3					2	1			1		1
CO5	3	2				1				1	3	1
CO6	3	3	3		1				2	1	3	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	40	30	76
Apply		10	14
Analyse			
Evaluate			
Create			

Mark distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

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

Course Level Assessment (Sample) Questions

CO1: Describe the properties of materials used in construction

1. Write a short note on manufacturing process of cement.
2. Explain any three laboratory tests on cement and its IS specifications.
3. Write a note on quality of water used for concrete.
4. Explain the various types of admixtures and their uses.

CO2: Explain the properties of concrete and its determination

1. Explain briefly the manufacturing process of concrete.
2. Explain a method to assess the workability of concrete. Also highlight the merits and demerits of the test.
3. Explain the factors affecting bleeding and segregation of concrete.
4. Explain the various factors affecting strength of concrete.

CO3: Describe the various elements of building construction

1. Discuss the purpose of providing damp proof course.
2. Distinguish between plastering and pointing.
3. Explain the various types of pointing with neat sketches.
4. State the advantages and disadvantages of framed structures.

CO4: Explain the technologies for construction

1. Explain voided slab construction.
2. Describe the classification of scaffolding.
3. Explain slipform construction.
4. Discuss the general reasons of building failure.

CO5: Describe the procedure for planning and executing public works

1. Differentiate between earnest money deposit and security deposit.
2. Discuss the advantages of a lump sum contract over an item-rate contract.
3. Explain the life cycle of a construction project.
4. Explain the process of tendering for a construction project.

CO6: Apply scheduling techniques in project planning and control

1. The following details regarding a project are given.

Activity	A	B	C	D	E	F	G	H	I	J
Immediate Predecessor	-	A	A	B	B	C	C	D	E, F	G
Duration (Days)	5	2	6	4	4	2	3	8	7	2

- (a) Prepare an Activity on Node Diagram.

- (b) Find the expected duration of the project.
- (c) Determine the critical activities.
- (d) Compute the total and free float of all the activities.

2. For the project details given below:

- (a) Draw the network.
- (b) Prepare the schedule of activities
- (c) What is the project completion time?
- (d) Which is the critical path?
- (e) Determine the probability of completing the project in 55 days?

Activity	A	B	C	D	E	F	G	H	I
Predecessor	-	A	A	B	B	C	E	D,F	G,H
a	4	5	4	15	10	8	4	1	6
m	6	7	8	20	18	9	8	2	7
b	8	15	12	25	26	16	12	3	8

SYLLABUS

Module 1

Construction Materials

Timber products –properties and uses of veneer, plywood, fibre board, particle board, multi wood

Cement: Manufacturing, chemical composition, Tests on cement – specific gravity, standard consistency, initial and final setting time, fineness, soundness, compressive strength, IS specifications

Aggregates – types, Gradation, importance of gradation, bulking of fine aggregate

Quality of water for construction (Brief discussion only, Permissible limits of chemical constituents not required)

Admixtures, uses – mineral admixtures – fly ash and ground granulated blast furnace slag and chemical admixtures – plasticizers, super plasticizers, accelerators, retarders (brief discussion only)

Module 2

Concrete and Building Construction

Process of manufacturing concrete – batching, mixing, transportation, placing, compacting, finishing, curing

Properties of fresh concrete: Workability, factors affecting workability, test on workability (slump test), segregation and bleeding (brief discussion)

Properties of hardened concrete: Strength, factors affecting strength, tests for strength of concrete in compression, tension and flexure

Lintels and arches: Types and construction details

Damp proof course (brief discussion only)

Finishing works: Plastering, pointing, painting – objectives and types

Structural systems – load bearing and framed construction, RCC and steel framed structures

Module 3

Construction Technology

Cost-effective construction – rapid wall construction, soil-cement block masonry, voided slab technology, filler slab technology (brief discussion only)

Scaffolding – uses and classification (brief discussion only)

Formwork – requirements of good formwork, classification, slipform (brief discussion only)

Prefabricated construction – advantages and disadvantages, prefabricated building components.

Basic concept of prestressing – fundamental understanding of pre-tensioned and post-tensioned construction

Construction 3D printing (brief discussion only)

Building failures – general reasons

Causes of failures in RCC, steel and masonry structures

Module 4

Construction Project Management

Construction projects, categories, life cycle of a project – pre-project phase, project phase, post-project phase, Detailed Project Report – contents

Tendering: types of tenders, stages in tendering

Contracts: types of contracts – item rate contract, lumpsum contract, percentage rate contract, turnkey contracts, concession contracts – BOT

Module 5

Construction Planning

Work break down structure

Types of Schedules – Construction schedule, Material schedule, labour schedule, equipment schedule, financial schedule

Bar chart, Mile Stone Charts

Networks, Network representation – Activity on Node (AoN) Diagram

Network analysis – Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT) – concepts and problems

Text books:

1. Shetty M.S. and A. K. Jain (2019), Concrete Technology: Theory and Practice, S. Chand & Company Pvt. Ltd.
2. Varghese P. C. (2007), Building Construction, Prentice Hall India.
3. Punmia B. C., Ashok Kumar Jain and Arun Kumar Jain (2016), Building Construction, Laxmi Publications (P) Ltd.
4. Sharma S.C. and S.V. Deodhar (2019), Construction Engineering & Management, Khanna Book Publishing Co. (P) Ltd.
5. Kumar Neeraj Jha (2015), Construction Project Management: Theory and Practice, Pearson India Education Services Pvt.Ltd.

Reference books:

1. Sahu G. C. and Joygopal Jena (2015), Building Materials and Construction, McGraw Hill Education (India) Private Limited.
2. Gambhir M. L. (2004), Concrete Technology, Tata McGraw-Hill Publishing Company Limited.

3. Sharma S.K. (2019), Civil Engineering Construction Materials, Khanna Book Publishing Co. (P) Ltd.
4. Neville A.M. and Brooks J.J. (2010), Concrete Technology, Pearson Education Ltd.
5. Mehta P. K. and Paulo J. M. Monteiro (2014), Concrete-Microstructure, Properties and Materials, McGraw Hill Education.
6. Santhakumar R. (2006), Concrete Technology, Oxford Universities Press India.
7. Tony Bryan (2010), Construction Technology – Analysis and Choice, Wiley-Blackwell.
8. Joseph J. Moder, Cecil R. Philips and Edward W. Davis (1983), Project Management with CPM, PERT and Precedence Diagramming, Van Nostrand Reinhold Company Inc.
9. Charles Patrick (2012), Construction Project Planning and Scheduling, Dorling Kindersley India Pvt. Ltd.
10. Daniel W. Halpin and Bolivar A. Senior (2011), Construction Management, John Wiley and Sons Inc.

Lecture Plan

Module	Topic	Course Outcomes addressed	No. of Lectures
1	Module I (6 hours)		
1.1	Timber products – properties and uses of veneer, plywood, fibre board, particle board, multi wood	CO1	1
1.2	Cement – Manufacturing, chemical composition	CO1	1
1.3	Tests on cement – specific gravity, standard consistency, initial and final setting time, fineness, soundness, compressive strength, IS specifications	CO1	1
1.4	Aggregates – types, Gradation, importance of gradation, bulking of fine aggregate	CO1	1
1.5	Quality of water for construction (Brief discussion only, Permissible limits of chemical constituents not required) Admixtures, uses – mineral admixtures – fly ash and	CO1	2

	ground granulated blast furnace slag and chemical admixtures – plasticizers, superplasticizers, accelerators, retarders (brief discussion only)		
2	Module II (8 hours)		
2.1	Concrete manufacturing – batching, mixing, transportation, placing, compacting, finishing, curing	CO2	2
2.2	Properties of fresh concrete: Workability, factors affecting workability, test on workability (slump test), segregation and bleeding (brief discussion)	CO2	1
2.3	Properties of hardened concrete: Strength, factors affecting strength, tests for strength of concrete in compression, tension and flexure	CO2	1
2.4	Lintels and arches: Types	CO3	1
2.5	Damp proof course (brief discussion only), Finishing works: Plastering, pointing (objectives and types)	CO3	1
2.6	Painting (objectives and types)	CO3	1
2.7	Structural systems – load bearing and framed construction, RCC and steel framed structures	CO3	1
3	Module III (6 hours)		
3.1	Cost-effective construction – rapid wall construction, soil-cement block masonry, voided slab technology, filler slab technology (brief discussion only)	CO4	1
3.2	Scaffolding – uses and classification (brief discussion only)	CO4	1
3.3	Formwork – requirements of good formwork, classification, slipform (brief discussion only)	CO4	1
3.4	Prefabricated construction – advantages and disadvantages, prefabricated building components. Basic concept of prestressing – fundamental understanding of pre-tensioned and post-tensioned	CO4	1

	construction Construction 3D printing (brief discussion only)		
3.5	Building failures – general reasons Causes of failures in RCC, steel and masonry structures	CO4	2
4	Module IV (7 hours)		
4.1	Introduction to construction project management, construction projects, categories	CO5	1
4.2	Life cycle of construction project – pre-project phase, project phase, post-project phase, Detailed Project Report – contents	CO5	2
4.3	Tendering, types of tenders, stages in tendering	CO5	2
4.4	Contracts – types of contracts – item rate contract, lumpsum contract, percentage rate contract, turnkey contracts, concession contracts – BOT	CO5	2
5	Module V (8 hours)		
5.1	Introduction to construction planning and scheduling, Work break down structure	CO6	1
5.2	Types of Schedules: Construction schedule, Material schedule, labour schedule, equipment schedule, financial schedule	CO6	1
5.3	Bar chart, Mile Stone Charts	CO6	1
5.4	Introduction of networks, Network representation – Activity on Node (AoN) Diagram, Critical Path Method (CPM) – concepts and problems on determination of critical path, floats	CO6	3
5.5	Programme Evaluation and Review Technique (PERT) – concepts and problems	CO6	2

MODEL QUESTION PAPER

Reg.No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CET309

Course Name: **CONSTRUCTION TECHNOLOGY AND MANAGEMENT**

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks.

1. Explain bulking of fine aggregate.
2. State the IS specification for initial and final setting time of OPC.
3. Discuss the various objectives of plastering.
4. List the various requirements of an ideal paint.
5. Briefly describe rapid wall construction technology.
6. Explain 3D printing in construction.
7. Discuss the advantages and disadvantages of an item-rate contract.
8. Explain selective tendering.
9. Explain the three time estimates in PERT.
10. Illustrate the use of a material schedule in organizing construction activities at a site.

(10×3 marks = 30 marks)

PART B

Answer one full question from each module. Each full question carries 14 marks.

Module I

11. a) Discuss the role of plasticizers in concrete. (6 marks)
- b) Differentiate between fibre board and particle board. (8 marks)

OR

12. a) Discuss the chemical composition of cement. (5 marks)
- b) Explain gradation of aggregates. Discuss the significance of gradation of aggregates. (9 marks)

Module II

13. a) Define workability of concrete. Explain the factors affecting workability. (5 marks)
b) Explain any three laboratory tests on hardened concrete. (9 marks)

OR

14. a) Explain various types of arches with neat sketches. (8 marks)
b) Distinguish between RCC framed and steel framed structures. (6 marks)

Module III

15. Explain the causes of failure in RCC structures. (14 marks)

OR

16. a) Discuss the advantages and disadvantages of prefabricated construction. (6 marks)
b) Explain filler slab technology. (8 marks)

Module IV

17. Discuss the details included in the DPR of an infrastructure project. (14 marks)

OR

18. Explain the project formulation stage of a construction project. (14 marks)

Module V

19. For the given data, draw an AON network and determine the critical path. Also find the total float, free float and independent float of each activity.

Activity	A	B	C	D	E	F	G	H	I
Predecessor	-	A	A	C	B	B, D	C	F, G	E, H
Duration (days)	4	6	4	2	4	5	3	4	2

(14 marks)

OR

20. The table shows the details of various activities of a small project.

Activity	A	B	C	D	E	F	G	H	I	J
Predecessor	-	-	A	A	B	E	C	D, F	H	G
Optimistic	4	3	7	5	6	2	3		2	6

time (days)										
Most likely time (days)	6	5	8	7	7	3	4	9	4	8
Pessimistic time (days)	8	7	9	9	8	4	5	11	6	10

- a) Draw an AON network and calculate the project completion time with 50% probability.
- b) Find the probability of completing the project in (i) 30 days; (ii) 26 days.
- c) What project completion date has 80% chance of being met? (14 marks)

CEL331	MATERIAL TESTING LAB II	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	3	2019

Preamble: The course aims to enrich the students to gain hands-on experience in conducting laboratory tests on various construction materials and thereby evaluate material quality and performance.

Prerequisite: Basics of Construction Engineering Materials.

General Instructions to Faculty:

1. Any 12 of the 15 experiments included in the list of experiments need to be performed mandatorily. Virtual Lab facility cannot be used to substitute the conduct of these mandatory experiments.
2. The laboratory should have possession of modern testing equipment such as Rebound hammer, ultrasonic pulse velocity, rebar locator, core cutter, concrete penetrometer and crack detection microscope at least for demonstration purposes.
3. Periodic maintenance and calibration of various testing instruments needs to be made.
4. Use of data visualization packages such as may be required for making various plots.

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

Course Outcome	Course Outcome Description
CO 1	To describe the basic properties of various construction materials
CO 2	Characterize the physical and mechanical properties of various construction materials.
CO3	Interpret the quality of various construction materials as per IS Codal provisions.

Mapping of course outcomes with program outcomes:

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

Assessment Pattern:

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test (Immediately before the second series test)	:	30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work	:	15 Marks
(b) Implementing the work/Conducting the experiment	:	10 Marks
(c) Performance, result and inference (usage of equipment and trouble shooting)	:	25 Marks
(d) Viva voce	:	20 marks
(e) Record	:	5 Marks

General instructions:

Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

References

1. M.S.Shetty , Concrete Technology, Theory and Practice , S.Chand&Company, 2014
A.M.Neville and J.J Brooks, Concrete Technology,Second edition, Pearson.
2. **IS codes on cement:**IS 1489(Part 1& 2):1991 Specification for Portland pozzolana cement,IS 269:1989 – Specification for ordinary Portland cement, 33 grade,IS 8112 : 2013- Specification for ordinary Portland cement, 43 grade, IS 12269 : 2013- Specification for ordinary Portland cement, 53 grade,
3. **IS codes on aggregate:**IS 2386(Part 1):1963 Methods of test for aggregates for concrete: Part 1 Particle size and shape, IS 2386(Part 3):1963 Methods of test for aggregates for concrete: Part 3 Specific gravity, density, voids, absorption and bulking, IS 383:1970Specification for Coarse and Fine aggregate from natural sources of concrete
4. **IS codes on fresh and hardened concrete:** IS 1199:1959 Methods of sampling and analysis of concrete, IS 10262:2019 Concrete mix proportioning- Guidelines, IS 516:1959 Methods of tests for strength of concrete.
5. **IS codes on brick and tiles:**IS 3495 (Part 1 to 4):1992 Methods of tests of burned clay bricks,IS 1077:1992 Common burned clay building bricks (specification),IS 654:1992 Clay roofing tiles Mangalore pattern (specification).
6. IS 13311 (Part 1 & 2):1992Non - destructive testing of concrete-methods of test.

SYLLABUS

- Exercise 1. Testing of Cement: Fineness, normal consistency, initial & final setting time.
- Exercise 2. Testing of Cement: Specific gravity and compressive strength
- Exercise 3. Study on soundness of cement.
- Exercise 4. Testing of Coarse and Fine Aggregate: Sieve analysis.
- Exercise 5. Testing of Coarse and Fine Aggregate: Water absorption, bulk density, void ratio, porosity and specific gravity.
- Exercise 6. Test on bulking of sand.
- Exercise 7. Test on coarse aggregate crushing value
- Exercise 8. Tests on fresh concrete : Measurement of workability of concrete by slump cone test and compacting factor test.
- Exercise 9. Study on workability of concrete by Vee-Bee test and flow test.
- Exercise 10. Concrete mix design by IS code method and casting of cubes, cylinders with designed concrete mixes.
- Exercise 11. Tests on hardened properties of concrete: Compressive, split and flexural strength.
- Exercise 12. Tests on hardened properties of concrete: Modulus of elasticity of concrete
- Exercise 13. Tests on brick, floor and roof tiles as per IS codal provision.
- Exercise 14. Study on Non-destructive tests on hardened concrete (Rebound hammer, ultrasonic pulse velocity and Rebar locator).
- Exercise 15. Study on concrete core cutter, concrete penetrometer and crack detection microscope.

CEL 333	GEOTECHNICAL ENGINEERING LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2019

Preamble:

Objective of the course is to familiarize students with the laboratory tests used to determine physical, index and engineering properties of geomaterials.

Prerequisite: CET 204 GEOTECHNICAL ENGINEERING I

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

CO1	Identify and classify soil based on standard geotechnical experimental methods.
CO2	Perform and analyze permeability tests.
CO3	Interpret engineering behavior of soils based on test results.
CO4	Perform laboratory compaction, CBR and in-place density test for fill quality control in the field.
CO5	Evaluate the strength of soil by performing various tests viz. direct shear test, unconfined compressive strength test and triaxial shear test.
CO6	Evaluate settlement characteristics of soils.

Mapping of course outcomes (COs) with program outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				1				2	2		
CO2	3				2				2	2		
CO3	3	2							2	2		
CO4	3				1				2	2		
CO5	3				2				2	2		
CO6	3	1			2				2	2		

Mark distribution

Total Marks	Continuous Internal Evaluation (CIE)	End Semester Examination (ESE)	End Semester Examination (ESE) Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.

- a) Preliminary work : 15 marks
- b) Implementing the work/ Conducting the experiment : 10 marks
- c) Performance, result and inference (usage of equipments and trouble shooting) : 25 marks
- d) Viva voce : 20 marks
- e) Record : 5 marks

General instructions:

Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

References

1. IS codes relevant to each test
2. C. Venkatramaiah, Geotechnical Engineering, New Age International publishers, 2012
3. Gopal Ranjan and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2012
4. K. R. Arora, Soil Mechanics and Foundation Engineering, Standard Publishers, 2011

SYLLABUS

Part A

Estimation of physical and index properties of the given soil: After performing the set of experiments, students are expected to infer the results of the experiments in their engineering behavior.

1. Determination of Water Content and Specific Gravity
2. Sieve Analysis
3. Hydrometer/pipette Analysis
4. Atterberg Limits (Liquid Limit, Plastic Limit and Shrinkage Limit)
5. Swelling Test

6. Field Density determination

Part B

Determination of engineering properties of the given soil: Students should be familiarize with the tests to be performed to determine the engineering properties of the given soil and interpret the results for field application.

7. Permeability Test
8. Standard Proctor Compaction Test
9. Heavy compaction
10. California Bearing Ratio Test
11. Direct Shear test
12. Unconfined Compression Test
13. Consolidation Test

Study/demonstration

14. Triaxial test

SEMESTER V

MINOR

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember/ Understand	20	20	30
Apply	30	30	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

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

Course Level Assessment (Sample) Questions

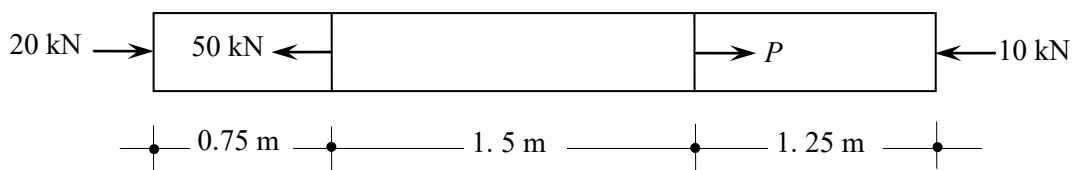
CO1: Recall the fundamental terms/theorems associated with mechanics of linear elastic deformable bodies and explain the behavior/response of various structural elements under various loading conditions.

1. Explain Hooke's law.
2. Sketch the stress-strain curve of mild steel and mark the salient points
3. Explain the concept of BM and SF in beams, with the help of a cantilever beam subjected to uniformly distributed load over the whole span.
4. What is pure bending? Give an example.
5. What is point of contraflexure?
6. Explain (i) Section modulus and (ii) Moment of resistance

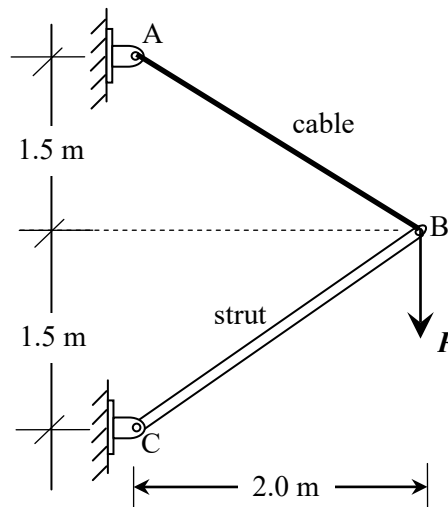
7. Distinguish between statically determinate and statically indeterminate structures.
8. What is degree of static indeterminacy? Explain with an example.
9. Explain (i) distribution factor and (ii) carry over moment.
10. Compare slope-deflection and moment distribution methods.

CO2: Calculate the stresses/strains in structural elements subjected to axial load and bending/twisting moments.

1. A 32 mm diameter steel bar is subjected to forces as shown in figure. Find the value of P necessary for equilibrium and stresses in different segments. Also calculate the final length of the bar. Take $E = 200$ GPa.



2. A strut and cable assembly ABC, shown in figure supports a vertical load $P = 10$ kN. The cable has an effective cross sectional area of 120 mm^2 and the strut has an area of 200 mm^2 . Calculate the normal stresses induced in the cable and the strut and indicate whether they are tension or compression. If the cable elongates 1.15 mm and the strut shortens 0.58 mm find the strains also.

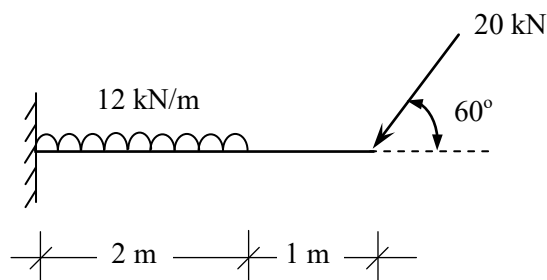


3. A tension test is carried out on a mild steel bar of 10 mm diameter. The bar yields under a load of 20 kN, it reaches a maximum load of 40 kN and breaks at 25 kN. The diameter of the bar at breaking was found to be 7 mm. The increase in length of the bar over a gauge length of 50 mm was found to be 0.029 mm under a load of 10 kN. Estimate (a) Young's modulus, (b) yield strength, (c) ultimate strength and (d) actual breaking strength.
4. A steel flat 25 mm wide and 6 mm thick is required to be bend into a circular arc of radius 10 m. Find the bending moment required to bend the flat. Also find the maximum stress induced. Take $E = 200$ GPa.

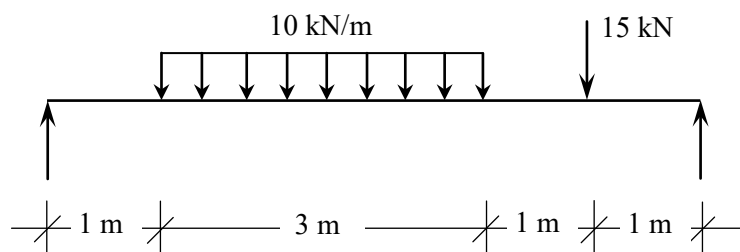
5. A steel box section $100 \text{ mm} \times 150 \text{ mm}$ with thickness 5 mm is used as a cantilever beam of span 2 m . If the beam carries a load of 1 kN at the free end, find the maximum bending stress at the mid span and the support. Neglect weight of the beam.
6. A timber beam $150 \text{ mm} \times 200 \text{ mm}$ is used as a simply supported beam of span 3 m . Find the maximum load that can be applied at 1 m from one of the supports, if the maximum bending stress in the beam is not to exceed 8 N/mm^2 . Neglect self weight of beam.
7. A beam of I section 400 mm deep has flanges 200 mm wide and 20 mm thick and web 15 mm thick. Compare its moment of resistance with that of a beam of rectangular section of the same weight, the depth being twice its breadth.
8. A solid circular shaft of diameter 50 mm is subjected to a torque. If the maximum shear stress induced in the shaft is 70 MPa , find the torque applied. If the modulus of rigidity of the material of the shaft is 80 GPa , find the angle of twist per meter length of the shaft.

CO3: Analyse statically determinate beams and trusses to determine the internal forces.

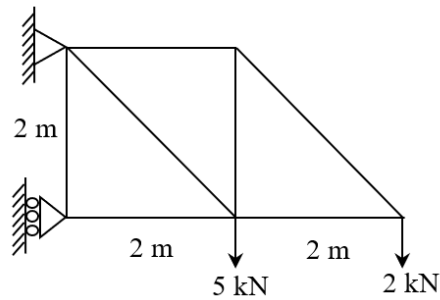
1. Draw the SFD and BMD of the beam shown.



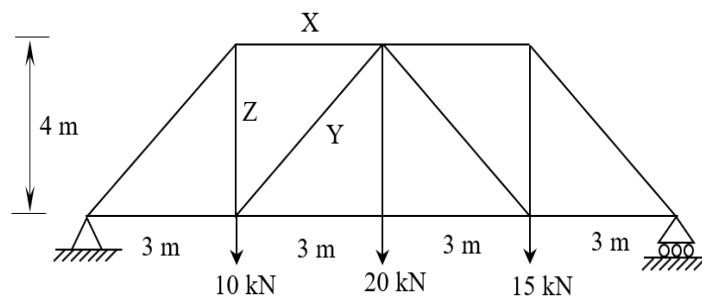
2. Draw SFD and BMD. Find the maximum BM also.



- Analyse the truss by method of joints and determine the forces in all members.

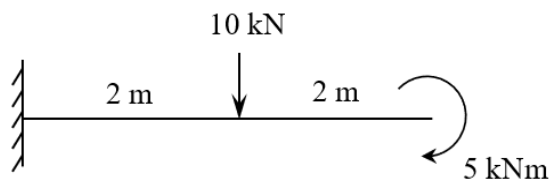


- Analyse the truss by method of sections and determine the forces in members X, Y and Z.



CO4: Determine the deflection of statically determinate beams.

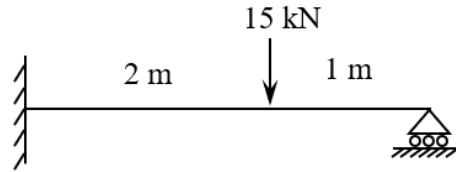
- A cantilever beam of span 3 m carries a point load of 10 kN at the free end along with a udl of 5 kN/m covering a distance of 2 m starting from the support. Find the maximum deflection of the beam. Take $EI = 3500 \text{ kNm}^2$.
- Find the slope and deflection at the free end of the cantilever beam loaded as shown. Flexural rigidity (EI) of the beam may be assumed to be constant.



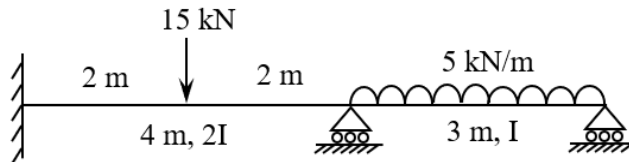
- A simply supported beam of span 5 m carries a concentrated load of 20 kN at a distance of 2 m from the left support. Find the slope at supports and deflection under the load. Also find the maximum deflection and its location. Flexural rigidity of the beam is 2200 kNm^2 .
- A simply supported beam of span 4 m carries a udl of 10 kN/m covering half the span starting from the left support. Find the slope at supports and maximum deflection. Locate the point of maximum deflection also. Flexural rigidity of the beam is 1500 kNm^2 .

CO5: Analyse statically indeterminate beams and frames.

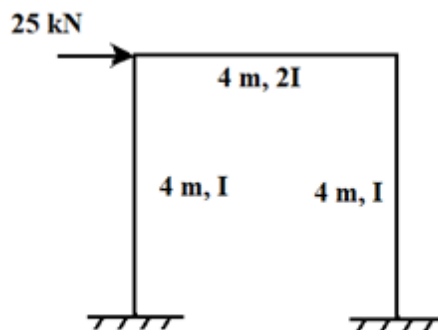
1. Analyse the propped cantilever beam shown by consistent deformation method and draw BMD and SFD.



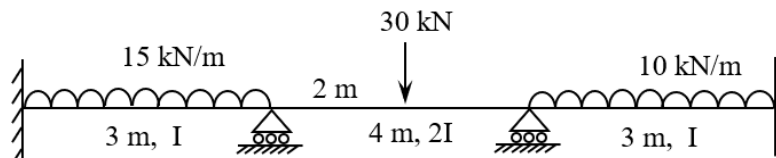
2. Analyse the continuous beam by slope deflection method and draw BMD.



3. Analyse the frame by slope deflection method and draw BMD.



4. Analyse the frame shown in Question 2 using moment distribution method and draw BMD.
5. Analyse the continuous beam shown using moment distribution method and draw BMD.



SYLLABUS

Module – 1

Review of statics, Concept of stress and strain – types, Stress – strain relation - Hooke's law, Young's modulus of elasticity.

Axially loaded bars with uniform cross section–stress, strain and deformation.

Deformation of axially loaded bars with varying cross section and bars with varying axial loads.

Torsion of circular shafts – stress and deformation, Power transmitted by circular shafts.

Module – 2

Analysis of truss – method of joints and method of sections.

Beams – different types. Types of loading on beams. Concept of bending moment and shear force.

Shear force and bending moment diagrams of cantilever beams and simply supported beams for different type of loads.

Module – 3

Theory of simple bending, assumptions and limitations.

Calculation of normal stress in beams, moment of resistance

Shear stress in beams (concept only).

Moment-curvature relation. Deflection of beams by successive integration.

Macaulay's method - Deflection of cantilever beams and simply supported beams.

Module – 4

Statically indeterminate structures, degree of static and kinematic indeterminacy.

Fixed beam – fixed end moments for simple cases of loading (No analysis required).

Method of consistent deformation - Analysis of propped cantilever beam and continuous beams with maximum two redundants.

Module – 5

Slope deflection method – Analysis of continuous beams with maximum two unknowns, effect of support settlement. Analysis of frames with sway.

Moment distribution method – analysis of continuous beams and frames without sway.

Text Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall International Series.
2. James M Gere, S.P. Timoshenko, Mechanics of Materials, CBS Publishers and Distributors, New Delhi.

- R. K. Bansal, A Text book of Strength of Materials, Laxmi Publications (P) Ltd, New Delhi.

References:

- R.C. Hibbeler, Structural Analysis, Pearson.
- Devdas Menon, Structural Analysis, Narosa Publications.
- H. J. Shah and S. B. Junnarkar, Mechanics of Structures Vol - I, Charotar Publishing House.
- S. Ramamrutham and R. Narayanan, Strength of Materials, Dhanpat Rai Publishing Co (P) Ltd.
- B. C. Punmia, Ashok K. Jain, Arun Kumar Jain, Mechanics of Materials, Laxmi Publications (P) Ltd, New Delhi.

Lecture Plan – Structural Mechanics

Module	Topic	Course Outcomes addressed	No. of Lectures
1	Module I: Total lecture hours: 9		
1.1	Review of statics – equilibrium conditions, free body diagrams, centroid, moment of inertia.	-	1
1.2	Concept of stress, types of stresses. Concept of strain, types of strains. Stress – strain relation - Hooke's law, Young's modulus of elasticity. Stress-strain ($\sigma - \epsilon$) diagram of mild steel.	CO1	1
1.3	Axially loaded bars with uniform cross section – calculation of stress, strain and deformation.	CO1, CO2	1
1.4	Deformation of axially loaded bars with varying cross section. Stepped bars, deformation of axially loaded bars with varying axial loads	CO1, CO2	3
1.5	Torsion of circular shafts, assumptions, derivation of torsion equation. Variation of stress across the cross section. Polar modulus.	CO1	1
1.6	Calculation stress and deformation of circular shafts subjected to torsion. Power transmitted by circular shafts.	CO1, CO2	2
2	Module II: Total lecture hours:10		
2.1	Analysis of truss – Method of joints	CO1, CO3	2

2.2	Analysis of Truss – Method of sections	CO1, CO3	2
2.3	Beams – different types. Types of loading on beams. Concept of bending moment and shear force. Shear force and bending moment diagrams.	CO1, CO3	2
2.4	Shear force and bending moment diagrams of cantilever beams subjected to point load, uniformly distributed load, uniformly varying load and concentrated moment.	CO3	2
2.5	Shear force and bending moment diagrams of simply supported beams subjected to point load and uniformly distributed load.	CO3	2
3	Module III : Total lecture hours : 9		
3.1	Theory of simple bending – derivation of equation, assumptions and limitations.	CO1, CO2	1
3.2	Calculation of normal stress in beams, moment of resistance. Problems involving bending stress. Shear stress in beams (concept only)- variation of shear stress across the cross section.	CO1, CO2	2
3.3	Moment-curvature relation. Basic differential equation for calculating the deflection of beams. Calculation of deflection by successive integration. Principle of superposition.	CO1, CO4	2
3.4	Macaulay’s method - Deflection of cantilever beam subjected to point load and uniformly distributed loads.	CO1, CO4	2
3.5	Macaulay’s method - Deflection of simply supported beams subjected to point load and uniformly distributed loads. Clerk Maxwell’s theorem of reciprocal deflection	CO1, CO4	2
4	Module IV: Total lecture hours:8		
4.1	Statically indeterminate structures, degree of static and kinematic indeterminacy - examples Force and displacement method of analysis (concept only)	CO1	1
4.2	Fixed beam – fixed end moments for simple cases of loading (No analysis required). BMD of fixed beam, point of contraflexure.	CO1, CO3	2
4.3	Method of consistent deformation - Analysis of propped cantilever beam.	CO1, CO5	2

4.4	Method of consistent deformation – analysis of beams with maximum two redundants.	CO1, CO5	3
5	Module V: Total lecture hours:9		
5.1	Slope deflection method – equation (no derivation required). Analysis of continuous beams with maximum two unknowns.	CO1, CO5	2
5.2	Slope deflection method – analysis of continuous beam with support settlement.	CO1, CO5	1
5.3	Slope deflection method – analysis of frames with sway.	CO1, CO5	2
5.4	Moment distribution method – concept. Distribution factor and carry over moment.	CO1, CO5	1
5.5	Moment distribution method – analysis of continuous beams.	CO1, CO5	1
5.6	Moment distribution method – analysis of frames without sway.	CO1, CO5	2

MODEL QUESTION PAPER

Reg. No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER BTECH DEGREE EXAMINATION

Course Code: CET381

Course Name: STRUCTURAL MECHANICS

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions; each question carries 3 marks.

- Sketch the stress-strain graph of mild steel and mark the salient points.
 - A steel bar of length 1 m and diameter 12 mm was found to elongate by 0.64 mm under an axial load of 15 kN. Find the stress induced and modulus of elasticity of the material.
 - What is the advantage of method of sections over method of joints in the analysis of trusses?
 - What is the relationship between SF and BM? Illustrate with a simple example.
 - What is pure bending? Give an example.
 - Using successive integration method, find the deflection at the free end of a cantilever beam carrying a point load at the free end.
 - Explain 'static indeterminacy' and 'kinematic indeterminacy' with a suitable example.
 - Write down the consistent deformation equations for a beam with degree of static indeterminacy = 2. Explain the basic terms in the equation.
 - What are the reasons for side sway in frames?
 - Write notes on (i) distribution factor and (ii) carry over moment.

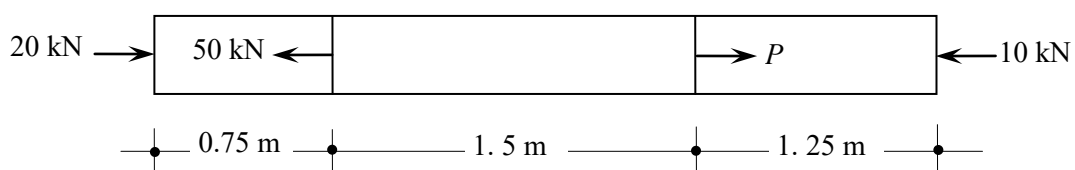
(10×3 marks = 30 marks)

PART B

Answer one full question from each module; each full question carries 14 marks.

Module I

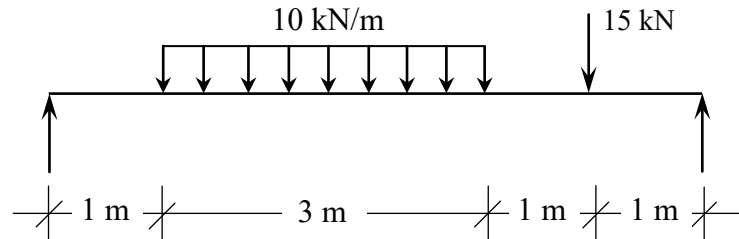
- A 32 mm diameter steel bar is subjected to forces as shown in figure. Find the value of P necessary for equilibrium and stresses in different segments. Also calculate the final length of the bar. Take $E = 200$ GPa.



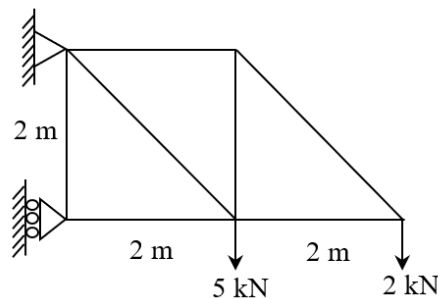
3. A tension test is carried out on a mild steel bar of 10 mm diameter. The bar yields under a load of 20 kN, it reaches a maximum load of 40 kN and breaks at 25 kN. The diameter of the bar at breaking was found to be 7 mm. The increase in length of the bar over a gauge length of 50 mm was found to be 0.029 mm under a load of 10 kN. Estimate (a) Young's modulus, (b) yield strength, (c) ultimate strength and (d) actual breaking strength.

Module II

4. Draw the SFD and BMD of the beam loaded as shown in figure. Find the maximum BM and locate the point of maximum BM also.



5. Analyse the truss by method of joints and determine the forces in all members.

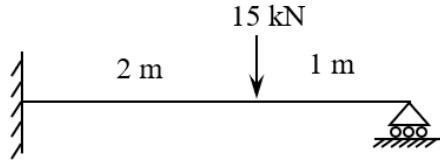


Module III

6. A beam of I section 400 mm deep has flanges 200 mm wide and 20 mm thick and web 15 mm thick. Compare its moment of resistance with that of a beam of rectangular section of the same weight, the depth being twice its breadth.
7. A simply supported beam of span 4 m carries a udl of 10 kN/m covering half the span starting from the left support. Find the slope at supports and maximum deflection. Locate the point of maximum deflection also. Flexural rigidity of the beam is 1500 kNm^2 .

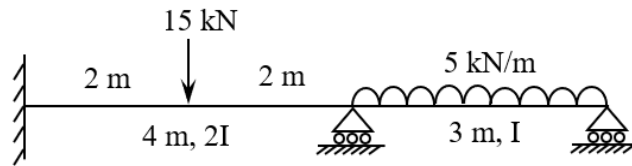
Module IV

8. a) Draw the BMD of a fixed beam carrying udl through out its span. (4 marks)
- b) Analyse the propped cantilever beam shown by consistent deformation method and draw BMD and SFD.



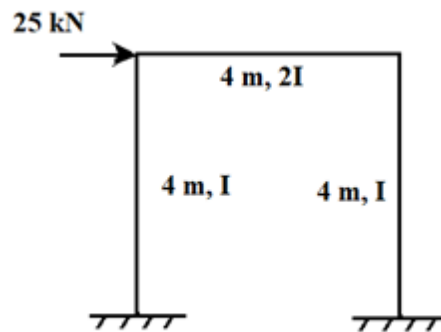
(10 marks)

9. Analyse the beam shown by consistent deformation method and draw BMD.

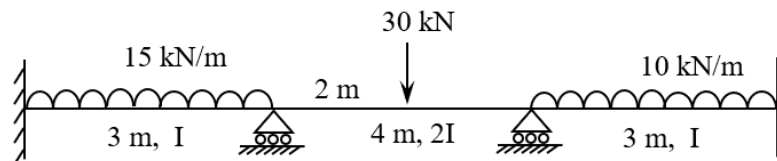


Module V

10. Analyse the frame by slope deflection method and draw BMD.



11. Analyse the continuous beam shown using moment distribution method and draw BMD.



CET383	ECO-FRIENDLY TRANSPORTATION SYSTEMS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		VAC	3	1	0	4	2019

Preamble : Objective of the course is to introduce the principles and practice of sustainability on transportation systems and development of an eco-friendly transport system.

Prerequisite: Nil

Course Outcomes:

	Description
CO No.	At the end of the course, students will be able to:
CO 1	Apply the basic principles of sustainability to infrastructure related problems
CO 2	Analyse Transportation network for eco-friendliness and quantify the levels.
CO 3	Design eco-friendly transportation systems
CO 4	Apply concepts of sustainability in developing green fuels and vehicles.
CO 5	Design for sustainability in public transport, Applications of tools like GIS, GPS.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	2	1		1	3	1		2		1	2	3
CO 2	2	2	1	2	1	1	1	1	1	1		1	2	2
CO 3	2	1	3	1	2	1	1	1	2	2	1	2	2	3
CO 4	2	2	2	1	1	2	2	1	1	1	1	2	2	3
CO 5	1	3	3	3	3	3	2	2	3	3	2	2	2	3

Model Question Paper

QP CODE:

Reg No.: _____

Name: _____

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

Course Code: CET 385

Course Name: SUSTAINABILITY ANALYSIS AND DESIGN

Max. Marks: 100

Duration: 3 hours

Answer All Questions- 10 ×3 =30marks
Each question carries 3marks

1. Narrate any one material characteristic that is needed to ensure sustainability.
2. Highlight any one approach that could enable products in the market to be preferred on environmental performance.
3. State any one of the observation from material flow analysis that would supplement sustainability evaluation.
4. What is embodied energy of a material?
5. Define footprint based sustainability indicators.
6. Illustrate the term “Reuse factor”
7. Additive operations in LCA
8. LCA helps to arrive at lower entropy form of a material. Substantiate the statement giving any one reason.
9. Prepare a short account on sustainable urbanization
10. How is energy efficiency linked with sustainable design process.

PART B

Each question carries 14marks

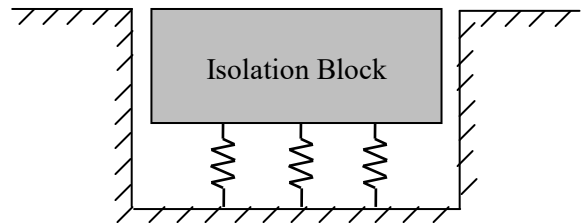
11. Identify any three engineering materials that are used as environmental substitutes for the conventional systems. Also narrate the factors considered in their selection based on engineering design requirement.
or
12. Explore the possibility of creating ecosystem based approach for construction process and highlight its significance to ensure sustainability.
13. “Buildings embody large quantity of material energy”. Prepare a short description narrating how this resource could be used to create energy efficient material use road map for Kerala.
or
14. Establish the industrial ecological model as an outcome of engineering models proposed for waste and material management.

the floor displacements at $t = 1$ s.

CO5: Analyse and design vibration isolation systems.

1. An instrument is attached to a rubber mounting having a static deflection of 3.6 mm. The supporting structure vibrates at a frequency of 30 Hz. If the damping is 3% of critical, estimate the % reduction in the transmitted support motion.
2. A delicate instrument of weight 200 kg is to be mounted on a factory floor using a vibration isolation suspension. The floor is vibrating with an amplitude of 0.25 mm and frequency 15 Hz. The maximum displacement that can be tolerated by the instrument for reliable operation is 0.1 mm. Find the stiffness of the suspension springs assuming 5% of critical damping.

3. A vibration isolation block (as shown in figure) is to be installed in a laboratory so that the vibration from adjacent factory operations will not disturb certain experiments. If the isolation block weighs 900 kg and the surrounding floor and foundation vibrates at 1500 cycles/minute, determine the stiffness of the isolation system such that the motion of the isolation block is limited to 20% of floor vibration. Assume damping as 10%.



CO6: Develop equations of motion for dynamic analysis of beams and perform free vibration analysis of simply supported beam.

1. Derive the differential equation governing the flexural vibration of beams.
2. Find the first three natural frequencies and mode shapes of a simply supported beam of span L having uniform flexural rigidity EI and mass \bar{m} per unit length. Sketch the mode shapes also.
3. A steel rod of 20 mm diameter having length 2.0 m is simply supported at its ends. Find its fundamental frequency of flexural vibration. Take density of steel as 7850 kg/m^3 . Modulus of elasticity of steel may be taken as 200 GPa.

SYLLABUS

Module I

Introduction – Parameters of dynamic system – D'Alembert's principle, Equation of motion of SDOF systems – undamped free vibration analysis. Damped free vibration analysis. Measurement of damping – Logarithmic decrement, Response to harmonic loading - steady state and transient states – steady state amplitude, Dynamic magnification factor.

Module II

Response of SDOF systems to rectangular load, triangular load and half sine pulse. Impulse response function, Response to general loads-Duhamel's integral. Response of SDOF system to support motion, Vibration Isolation, transmissibility

Module III

Multi degree of freedom systems – Lumped mass systems, shear building frame, Equation of motion, free vibration analysis, Natural frequencies and mode shapes, orthogonality of normal modes.

Module IV

Forced vibration analysis of multi degree of freedom systems – mode superposition method. Response of MDOF systems subjected to harmonic load. MDOF system subjected to support motion.

Module V

Introduction to earthquake analysis - Response spectrum. Response spectrum analysis of MDOF systems. Distributed parameter systems, Differential equation – beam flexure (elementary case), undamped free vibration analysis of simply supported beams.

Text Books:

- 1) Mario Paz, *Structural Dynamics*, CBS Publishers, New Delhi, India, 2001.
- 2) Mukhopadhyay M., *Vibrations, Dynamics and Structural Systems*, Taylor & Francis, London, 2000.

References:

- 1) Clough R. W. and J. Penzien, *Dynamics of Structures*, McGraw Hill, 1993.
- 2) Chopra A. K., *Dynamics of Structures- Theory and application to Earthquake Engineering*, Pearson Education India, 2007.
- 3) Biggs J. M., *Introduction to Structural Dynamics*, McGraw-Hill Book Inc., New York, 1964.
- 4) J.W. Smith, *Vibration of Structures*, Chapman and Hall, London.

CET397	GROUND WATER HYDROLOGY	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: The general objective of this course is to expose the students to the fundamental concepts of groundwater hydrology and its engineering applications. The course aim to impart the knowledge on the hydraulics of subsurface fluid flow, characteristics of porous media, well flow near aquifer boundaries, surface investigation of ground water, quality of ground water, artificial recharge and ground water flow modeling.

Pre-requisite: NIL

Course outcome

After the course, the student will be able to:

CO1	Understand the occurrence and movement of ground water through porous media and apply Darcy's law to simple ground water flow problems
CO2	Determine the aquifer parameters using different methods
CO3	Estimate drawdown in wells due to the effect of aquifer boundaries and thickness of aquifers
CO4	Estimate sea water intrusion length and fresh water discharge into the sea
CO5	Perform numerical modeling of ground water system

CO-PO Mapping

CET397 Ground Water Hydrology		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	CO1	3	3					1					
	CO2	3	3					1					
	CO3	3	2					1					
	CO4	3	3					1					
	CO5	3	3					1					

Model Question Paper

QP CODE:

Reg No.: _____

Name: _____

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

Course Code: CET 322

Course Name: GEOTECHNICAL INVESTIGATION

Max. Marks: 100
hours

Duration: 3

Part A

(Answer all questions; each question carries 3 marks)

1. What are the objectives of soil exploration?
2. Differentiate preliminary investigation and detailed investigation.
3. Explain dilatancy correction to be applied to the N value.
4. List out the factors influencing SPT value.
5. Explain stabilization of borehole using Bentonite slurry.
6. Write the principle behind the seismic refraction method.
7. What are the precautions to be adopted during the transportation of sample?
8. Define i) Area ratio, ii) Inside clearance iii) Outside clearance
9. Differentiate between bore log and soil profile.
10. What is rock quality designation?

Part B

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

Module 1

11. a. Explain wash boring with the help of a sketch.
b. Explain the major steps involved in reconnaissance for a geotechnical investigation of a multi storied building.

OR

12. a. Differentiate preliminary investigation and detailed investigation.
b. Explain percussion drilling with the help of a sketch.

Module 2

13. a. The observed SPT value (N) in a deposit of fully submerged fine silty sand was 45 at a depth of 6.5m. The average saturated unit weight of soil is 19.5 kN/m³ Find the corrected SPT number.
b. Explain the factors influencing SPT value.

OR

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

Course Code: CET332

Course Name: **TRAFFIC ENGINEERING AND MANAGEMENT**

Model Question Paper

Max. Marks:100

Duration: 3 hrs

PART A

(Answer all Questions: Each question carries 3 marks)

- 1 Differentiate time mean speed and space mean speed.
- 2 Explain multi regime models citing examples.
- 3 Suggest traffic management measures so as to avoid locking of vehicle flow due to turning traffic.
- 4 Mention priority rules at intersections.
- 5 Explain base capacity and adjusted capacity.
- 6 Discuss the importance of passenger car units under heterogeneous traffic conditions.
- 7 How channelizing islands control speed and separate conflicts at intersections? Explain with sketches.
- 8 Which locations justify grade- separated intersections?
- 9 What is the basic difference between collision diagram and condition diagram?
- 10 What is the probability of involvement of exactly 5 drivers out of the 500 drivers who are employed in a bus operating company in an accident during a year. It has been found that on an average 1 in 100 drivers are involved in an accident every year.

(3 x 10=30 marks)

PART B

(Answer one full question from each module)

- 11 a. The data shown below were obtained from a highway stretch. Fit these data to Greenshields model and determine i) free speed ii) jam density iii) capacity and iv) speed at maximum flow 7

Speed (km/h)	Density (veh/km)
14.2	85
24.1	70
30.3	55
40.1	41
50.6	20

CET 362	ENVIRONMENTAL IMPACT ASSESSMENT	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PEC	3	0	0	3	2019

Preamble : This course introduces the methodologies for identifying, predicting, evaluating and mitigating the impacts on environment due to any developmental project or activities. Students will learn how to prepare an impact assessment report and devise an environment management plan. Sufficient background will be provided on the environmental clearance procedures in India.

Prerequisite: NIL

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	To appreciate the need for minimizing the environmental impacts of developmental activities	Understanding
CO2	To understand environmental legislation & clearance procedure in the country	Remembering, Understanding
CO 3	To apply various methodologies for assessing the environmental impacts of any developmental activity	Applying &Analysing
CO 4	To prepare an environmental impact assessment report	Analysing& Evaluating
CO 5	To conduct an environmental audit	Analysing &Evaluating

Mapping of course outcomes with program outcomes (Minimum requirement)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	-	-	-	2	2	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	-	-	-	-
CO 3	2	-	-	3	2	-	3	-	-	-	-	-
CO4	-	-	-	2	-	2	2	3	-	3	-	-
CO5	-	-	-	2	1	-	2	2	-	2	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	15
Understand	10	10	15
Apply	15	15	35
Analyse	15	15	35
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
 Continuous Assessment Test (2 numbers) : 25 marks
 Assignment/Quiz/Course project : 15 marks

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

Course Level Assessment Questions

CO1: To be able to appreciate the need for minimizing the environmental impacts of developmental activities

1. Explain the evolution of EIA in India
2. Explain why EIA is needed for developmental projects.
3. What are the different ways in which development projects impact the water quality and quantity?

CO 2: To be able to understand environmental legislation & clearance procedure in the country

1. Two municipalities in Kerala plan to set up a Common Municipal Solid Waste Management Facility (CMSWMF). Explain the procedure required for the Environmental Clearance (EC) for the project as per the EIA Notification of 2006. (All CMSWMFs are category B projects)
2. Describe the procedure for obtaining environmental clearance according to EIA notification 2006.
3. The Environment (Protection) Act, 1986 is called an umbrella legislation. Substantiate the statement.

CO3: To be able to apply various methodologies for assessing the environmental impacts of any developmental activity

1. Prepare a simple checklist for assessment of socio economic impact due to the development of a highway.
2. Explain overlay mapping as an EIA method
3. Explain how to predict the impact of a highway project on air quality

CO4: To be able to prepare an environmental impact assessment report

1. Explain the Terms of Reference (ToR) for EIA report of a highway project
2. Explain the structure of EIA report
3. Explain the importance of an environmental management plan.

CO5: To be able to conduct an environmental audit

1. Explain the need for environmental auditing
2. What are the different types of environmental audits?
3. Explain the importance of ISO 14001 standard.

SYLLABUS**Module 1**

Definition, Need for EIA, Evolution of EIA: Global & Indian scenario -Environmental legislations in India- The Water (Prevention & Control of Pollution) Act 1974, The Air (Prevention & Control of Pollution) Act 1981, The Environmental (Protection) Act 1986- Environmental standards for water, air and noise quality- EIA Notification 2006

Module 2

Environmental clearance process in India: Screening, Scoping, Public Consultation, Appraisal- Form 1-Category of projects-Generic structure of EIA report- Terms of Reference (ToR) -Types of EIA: strategic, regional, sectoral, project level- Rapid EIA and Comprehensive EIA- Initial Environmental Examination (IEE)

Module 3

EIA methodologies: Ad hoc, checklist, matrix, network and overlay-Impact Prediction, Evaluation and Mitigation-Prediction and assessment of the impact on water (surface water and groundwater), air, and noise environment- assessment of ecological impacts and Socio economic Impacts.

Module 4

Environmental Management Plan (EMP): Goal and purpose- Importance of EMP- Content of an EMP- Role of environmental monitoring program

Environment Audit: need for audit- audit types and benefits- environmental audit procedure

ISO 14001 standards: Importance, salient features - Stages in implementation- Benefits

Module 5

EIA case studies (Indian)- a highway project, a hydro electric power plant, an air port project, a quarry mining project and a solid waste management project

Text Books:

1. Larry W Canter, "Environmental Impact Assessment", McGraw Hill Inc. , New York, 1995
2. Betty Bowers Marriott, Environmental Impact Assessment: A Practical Guide, McGraw-Hill Professional, 1997
3. Environmental Impact Assessment, 2003, Y.Anjaneyulu, B.S Publications

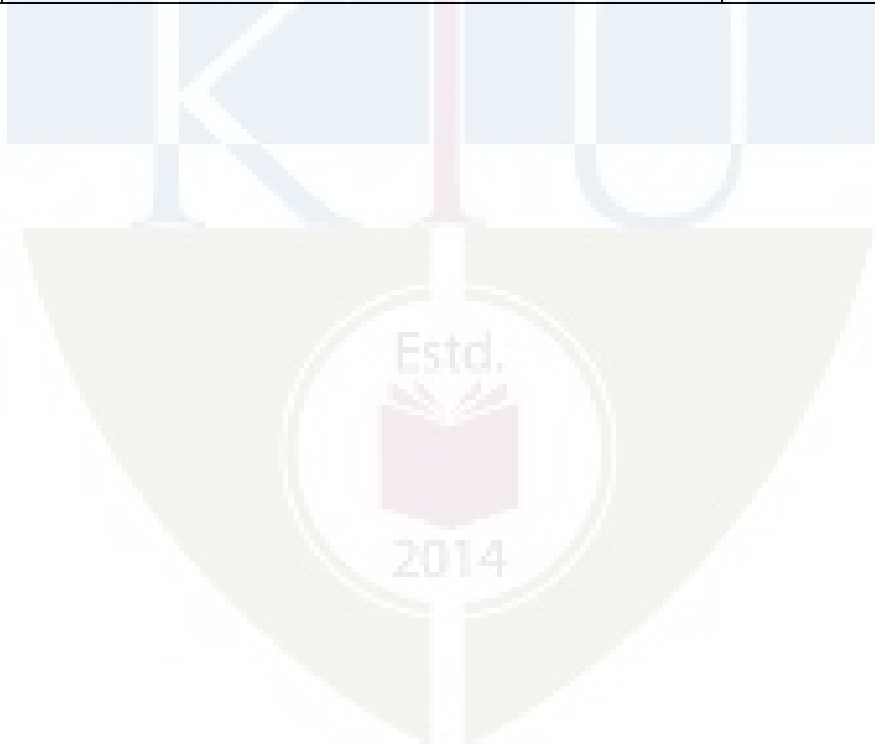
References:

1. Lawrence, David P., Environmental Impact Assessment (Practical Solutions to Recurrent Problems), Wiley International, New Jersey.
2. Ministry of Environment & Forests, Govt. of India 2006 EIA Notification
3. Jain, R.K., Urban, L.V. and Stacey, G.S., Environment Impact Analysis, Von Nostrand Reinhold Company.

Lecture Plan- Environmental Impact Assessment

Module	Topic	Course Outcomes addressed	No. of Lectures
1	Module 1: Total Lecture Hours -7		
1.1	Definition, Need for EIA, Evolution of EIA: Global & Indian scenario	CO1	1
1.2	Environmental legislations in India- The Water (Prevention & Control of Pollution) Act 1974, The Air (Prevention & Control of Pollution) Act 1981, The Environmental (Protection) Act 1986	CO2	3
1.3	Environmental standards for water, air and noise quality	CO2	1
1.4	EIA Notification 2006	CO2	2
2	Module II: Total Lecture Hours-7		
2.1	Environmental clearance process in India: Screening, Scoping, Public Consultation, Appraisal- Form1- Category of projects	CO2	3
2.2	Generic structure of EIA report- Terms of Reference (ToR)	CO4	1
2.3	Types of EIA: strategic, regional, sectoral, project level-	CO3	1
2.4	Rapid EIA and Comprehensive EIA	CO3	1
2.5	Initial Environmental Examination (IEE)	CO3	1
3	Module III: Total Lecture Hours-7		
3.1	EIA methodologies: Ad hoc, checklist, matrix, network and overlay	CO3	3
3.2	Impact Prediction, Evaluation and Mitigation- Prediction and assessment of the impact on water (surface water and groundwater), air, and noise	CO3	2

	environment		
3.3	assessment of ecological impacts and Socio economic Impacts	CO3	2
4	Module IV: Total Lecture Hours- 7		
4.1	Environmental Management Plan (EMP): Goal and purpose- Importance of EMP- Content of an EMP	CO4	2
4.2	Role of environmental monitoring program	CO4	1
4.3	Environment Audit: need for audit- audit types and benefits- environmental audit procedure	CO5	2
4.4	ISO 14001 standards: Importance, salient features - Stages in implementation- Benefits	CO5	2
5	Module V: Total Lecture Hours- 7		
5.1	EIA case studies (Indian)- a highway project	CO1, CO4	2
5.2	Hydro electric power plant, air port project	CO1, CO4	3
5.3	Quarry mining project, solid waste management project	CO1, CO4	3



Model Question Paper

Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CET362

Course Name: ENVIRONMENTAL IMPACT ASSESSMENT

Max. Marks: 100

Duration: 3 Hours

Part A

(Answer all questions; each question carries 3 marks)

1. Explain the need for EIA
2. Why environmental (protection) act, 1986 is called an umbrella act?
3. Discuss screening of projects
4. What is rapid EIA?
5. What is ad hoc method for impact assessment?
6. How to predict the impact of a proposed food industry on the water quality of a nearby river
7. Explain the benefits of an environmental audit
8. What is ISO 14001 standard?
9. What are the impacts of a highway project on local air quality
10. Discuss the environment monitoring program for a quarry mining industry.

PART B

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

11. (a) Discuss environmental standards for water, air and noise (6 Marks)
 - (b) Discuss evolution of EIA in India (8 Marks)
- OR
12. (a) Discuss Air (Prevention & Control of Pollution) Act 1981 (5 Marks)
 - (b) Explain salient features of EIA notification 2006 (9 Marks)
13. (a) Discuss environmental clearance process in India (10 Marks)
 - (b) What is Form-1 ? (4 Marks)

OR

14. (a) What is Initial Environmental Examination? (5 Marks)
(b) Explain different types of EIA (9 Marks)

15. (a) Discuss in detail EIA methodologies (10 Marks)
(b) How can air quality modelling help in assessing the impact on air (4 Marks)

OR

16. (a) Explain the steps to assess the impacts on the ecological environment due to a project (7Marks)
(b) Explain the steps involved in assessment of impacts on the water environment. (7 Marks)

17. (a) What are the different types of Environmental Audit? (5 Marks)
(b) Discuss the content of an environment management plan (9 marks)

OR

18. (a) Discuss the salient features of an Environmental Monitoring Plan (5 Marks)
(b) Explain in detail the procedure for conducting an environmental audit (9 Marks)

19. Explain environmental clearance procedure for an airport (14 Marks)

OR

20. Discuss how to assess the impacts of a hydro electric project (14 Marks)



CET372	FUNCTIONAL DESIGN OF BUILDINGS	Category	L	T	P	Credit	Year of Introduction
		PEC	3	0	0	3	2019

Preamble: The general objective of this course is to provide an insight to the students to various aspects of functional design of buildings and innovative construction methods.

Pre-requisite: CE204 Construction Technology

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

CO1	Develop an understanding of acoustical design and noise control techniques
CO2	Understand elemental concepts of natural and artificial lighting designs
CO3	Know the principles involved in the design of buildings for thermal comfort and influence of climate on design of buildings
CO4	Have basic concept for electrical load calculation, plumbing design, HVAC load Calculation, functioning of elevators and escalators and rough cost estimation.
CO5	Acquire knowledge of innovative construction concepts

CET372	Functional Design of Buildings		PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO1	3	3											
		CO2	3	3											
		CO3	3	3											
		CO4	3	3											
		CO5	3	3											

Assessment pattern

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

Continuous Internal Evaluation Pattern:

Attendance	:	10marks
Continuous Assessment Test (2numbers)	:	25 marks
Assignment/Quiz/Course project	:	15marks
Total	:	50marks

End semester examination pattern – There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14marks.

Course Level Assessment Questions

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

Course Outcome 1 (CO1)

1. Develop an understanding of acoustical design and noise control techniques
2. Applications of acoustics
3. Explain the acoustical considerations for offices, hospitals and industrial buildings

Course Outcome 2 (CO2)

1. Explain the purposes of lighting
2. Explain the basic concepts of natural and artificial lighting
3. Explain the different methods used for the design of natural lighting
4. Explain the different methods used for the design of artificial lighting

Course Outcome 3 (CO3)

1. Evaluate the principles involved in the design of buildings for thermal comfort
2. Explain the influence of climate on design of buildings
3. Compute solar radiation on different surfaces
4. Describe thermo physical properties of buildings

Course Outcome 4 (CO4)

1. Describe the basic concepts for electrical load calculation of structures
2. Explain the basic criteria for plumbing design
3. Calculation of HVAC load
4. Explain the functioning of elevators and escalators
5. Understand the rough cost estimation

Course Outcome 5 (CO5)

1. Understand traditional techniques in Tropical climate with vernacular buildings in Kerala
2. Explain the concepts of green building
3. Describe concepts for intelligent buildings
4. Explain innovative construction methods

Course Code: CET 372

FUNCTIONAL DESIGN OF BUILDINGS

Syllabus

Module I

Acoustical / Sonic Environment and acoustical comfort: Sound, Nature of sound- Behavior of sound in enclosed spaces-Concept of Geometric Acoustics-Reflection of sound and their applications- Absorption of sound-Sound absorption coefficient-Human Audibility range-Reverberation & Reverberation Time Calculation- Flanking paths- Sound absorption-materials and fixings- Reverberation-Sabine's formula-Eyrings modification.-Basic design of the elements for the required degree of sound insulation- Air and structure born noises-equivalent noise levels-day and night equivalent.

Acoustics, applications: Measures of noise control- Source-path and receiving end. TL value and computation of TL value, Acoustical defects- acoustical design of auditoriums and small lecture halls-Acoustical considerations of offices, hospitals and Industrial buildings.

Module II

Natural lighting: Visual task requirements, Units of Light, Light, Vision and Buildings, Standards of Lighting and Visual comfort-The sky as a source of light, Daylight factor, Daylight penetration- Calculation of daylight factor. Design of side-lit windows-BIS and CBRI methods-skylights

Artificial lighting: Artificial lighting- illumination requirements-lux meter – lamps and luminaries – polar distribution curves– Color temperature and color rendering index- glare - Design of artificial lighting – lumen method – point by point method. Basic idea of street lighting and outside lighting

Module III

Thermal comfort: Factors affecting thermal comfort- effective temperature- thermal comfort indices-ET-CET Charts- Bioclimatic chart- Psychrometry and Psychrometric chart.

Earth-Sun relationship: Sun's apparent movement with respect to the earth. Solar angles- Computation of solar radiation on different surfaces-solar path diagram-shadow-throw concept and design of shading devices

Thermal design of buildings: Thermo physical properties of building materials and thermal control: passive and active building design- Steady and periodic heat flow through building envelope.

Design approaches: Climate conscious designs- Climatic zones in India- orientation and shape of buildings in different climatic zones- Passive solar-Active solar and Active approaches. Requirements of buildings in tropical areas-Thermal insulation

Module IV

Functional elements: Concept for electrical load calculation of structures- basic criteria for plumbing design – basic concept of HVAC load calculation – Basic concept of functioning of elevators and escalators- basic cost estimation.

Functional protection: Causes of fire, Mechanism of fire spread in buildings, classification of fire-High temperature effects and combustibility of building materials and structure- Fire alarm system, and means of escape-Firefighting installations.

Module V

Functionality as per Vastusastra: Basic concepts- Governing criteria of functionality- Energy pattern- understand traditional techniques in Tropical climate with vernacular buildings in Kerala as case study.

Innovative concepts of functionality: Concept of green building- case studies on low energy and green buildings-Concepts of Intelligent building- Thirsty concrete- Blue roads- self healing concrete

Text Books and References:

1. Knudsen V.O. and Harris C.M., Acoustical Design in Architecture, John Wiley,1980
2. M David Egan , Architectural Acoustics, J.Ross Publishing,2007
3. Marshall Long, “Architectural Acoustics”, Second Edition, Academic Press, Waltham, USA, 2014
4. Bureau of Indian standards, Handbook on Functional Requirement of Buildings – SP:41(S and T)-1987
5. Pritchard, D.C., "Lighting", Longman Scientific & Technical, Harlow,1995.
6. Benjamin Evans, "Daylight in Architecture", McGraw - Hill Book Company, Newyork,1981.
- 7.Koenigseberger, Manual of tropical Housing and Building Part I – Climatic design, Orient Longman,2011
8. AjithaSimha.D, Building Environment, Tata McGraw Hill Publishing Co., New Delhi,1985
9. Jain. V.K., "Design and Installation of Services in Building complexes &High Rise Buildings", Khanna Tech. Publishers, New Delhi,1986.
10. National Building Code of India (NBC2016)
11. Wayne Forster and Dean Hawkes, “Energy Efficient Buildings: Architecture, Engineering, and Environment”. W.W. Norton Company Inc.2002.
12. Bureau of Energy Efficiency, India. Design Guidelines for Energy Efficient Multi-Storey Buildings,2014.



MODEL QUESTION PAPER

Reg. No.: _____

Name: _____

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

Course Code: CET372

Course Name: FUNCTIONAL DESIGN OF BUILDINGS

Max.Marks: 100

Duration: 3hours

Part A

(Answer all questions; each question carries 3 marks)

1. Write briefly about the audibility range of human beings. (3 Marks)
2. Discuss any three common acoustical defects seen in an auditorium. (3 Marks)
3. What are the advantages and disadvantages of sky lighting? (3 Marks)
4. Briefly describe polar distribution curves (3 Marks)
5. What are the thermal insulating materials used to maintain comfortable conditions inside a building? (3 Marks)
6. What do you understand by the following (i) Solar Constant (ii) Solar Azimuth (iii) Solar Altitude (3 Marks)
7. Write short note on "Handling capacity of Lifts" (3 Marks)
8. Briefly describe firefighting installations (3 Marks)
9. Describe self healing concrete. (3 Marks)
10. List out the advantages of self healing concrete. (3 Marks)

PART B

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

Module – 1

11. (a) TL value of a 16m^2 solid wall is 45 dB. If a hole of 2 cm^2 is drilled through it, find the reduction in TL value? (10 Marks)
- (b) Discuss how the TL value of a separating wall varies with its mass. (4 Marks)
12. (a) Explain how sound intensity varies with distance from a point source

- I. In free field
- II. In a reverberant field (8 Marks)
- (b) What you mean by Acoustical Day Time and Acoustical Night Time. Explain the concepts of L_{eq} and L_{dn} ? (6Marks)

Module – 2

13. (a) Explain the procedure of design of Artificial lighting by Lumen Method. (7 Marks)
- (b) A point source of light has an intensity 2000 candela in the vertically downward direction. The intensity reduces with the angle and reaches 1000 cd at the horizontal direction (90degrees with vertical). If the source is mounted 4m above the working plane, find the illumination due to this light source at points (i) directly under the lamp (ii) at 3m away in the same plane. (7 Marks)
14. (a) Define the different components of daylight factor? (6 Marks)
- (b) What do you understand by the concepts Passive solar design, Active solar design and active design? (8 Marks)

Module – 3

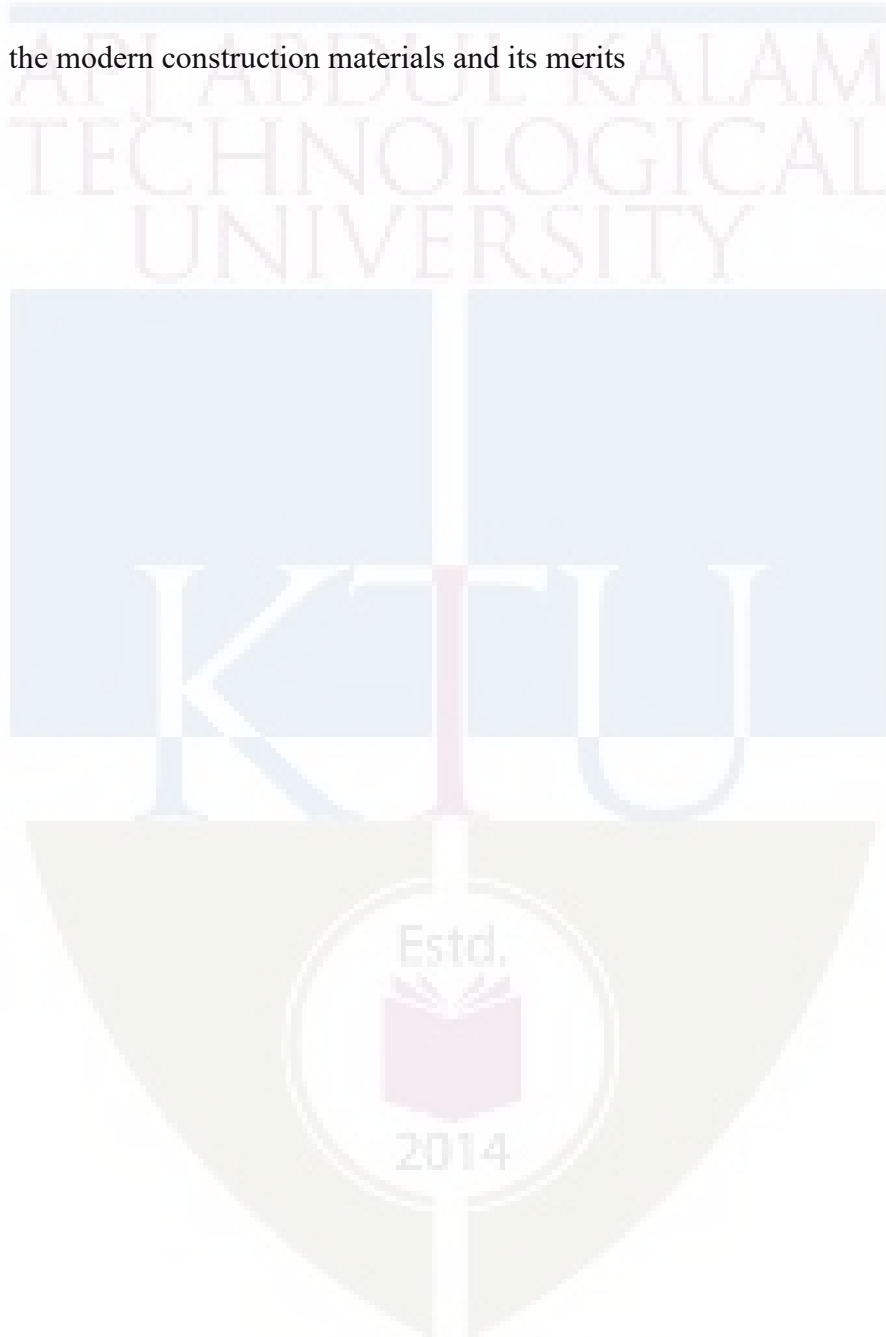
15. (a) Explain the considerations to be made in achieving thermal comfort in hot & dry and Warm and humid regions? (7 Marks)
- (b) Explain the concept of shadow angles and shadow throws. How shadow throws are used in the design of shading devices? (7 Marks)
16. (a) Explain the concept of comfort zone based on Bio-climatic chart (7 Marks)
- (b) What is Psychrometry? What are the usual input parameters to a Psychrometric chart? What are the various informations we get from a Psychrometric chart? (7 Marks)

Module – 4

17. Explain the features, operation arrangements, location and types of Elevators in public buildings. (14 Marks)
18. Explain the high temperature effects and combustibility of building materials and structures (14Marks)

Module – 5

19. (a) Explain the concepts of green building. (7 Marks)
(b) Describe LEED and GRIHA ratings for the evaluation of green buildings. (7 Marks)
20. Describe the modern construction materials and its merits (14 Marks)



APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER VI

MINOR



Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand	20	10	35
Apply	30	10	40
Analyse		30	25
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10marks
 Continuous Assessment Test(2numbers) : 25
 marksAssignment/Quiz/Courseproject : 15marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from modules 1 to 3 and 4 questions from module 4, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each full question carries 16 marks from module 1, 2 and 4 and 22 marks from module 3 and can have maximum 2 sub- divisions.

Note: For analysis of rate and cost estimation, unit rate and labour requirement should be given along with the questions in the question paper. No other charts, tables, codes are permitted in the Examination Hall. If necessary, relevant data shall be given along with the question paper.

Course Level Assessment Questions

CO1: Explain the specifications for various items of work associated with building construction

1.	Write the detailed specification of earth work in excavation
2.	Differentiate general specification and detailed specification with suitable example

CO2: Analyse the unit rates of different items of work associated with building construction

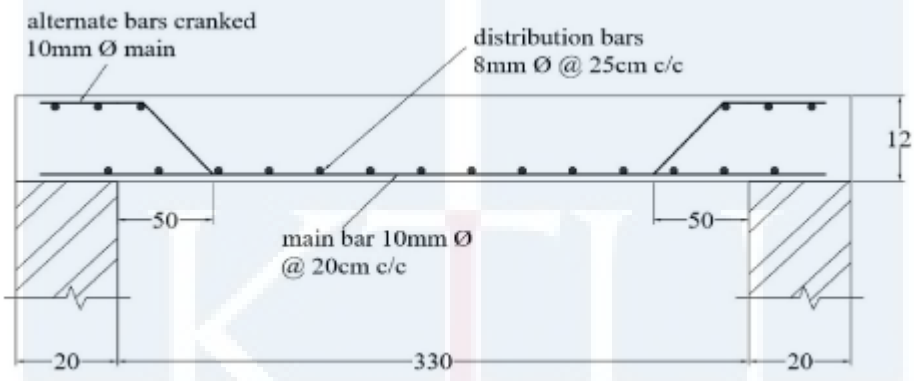
1.	Explain DAR and DSR.
2.	<p>Develop rate analysis for DSR item No.5.3, Reinforced cement concrete work with 1:1.5:3 (3 graded stone aggregate 20 mm nominal size) in beams, suspended floors, roofs having slope up to 15° landings, above plinth level up to floor five level, excluding the cost of centering, shuttering, finishing and reinforcement.</p> <p>Material: 20mm Aggregate 0.57m³@₹1300/m³, 10mm 0.28m³@ ₹1300/m³, coarse sand (Zone III) 0.425m³@₹1200/m³, Portland cement 400kg@₹5700/tonne.</p> <p>Labour : Mason 0.24@₹467/day, Beldar 2.75@₹368/day, Bhisti 0.90@₹407/day, Coolie 1.88@₹368/day</p> <p>Carriage provisions: Stone aggregate below 40mm 0.85m³@₹103.77, Portland cement 0.40tonne@₹5700/tonne.</p> <p>Hire Charges for concrete mixer 0.08@₹800/day, Vibrator needle type ₹0.08@350/day</p> <p>Sundries (LS) 14.30@₹1.73. Adopt water charges, contractor profit and overheads as per the CPWD DSR2018 provisions.</p>

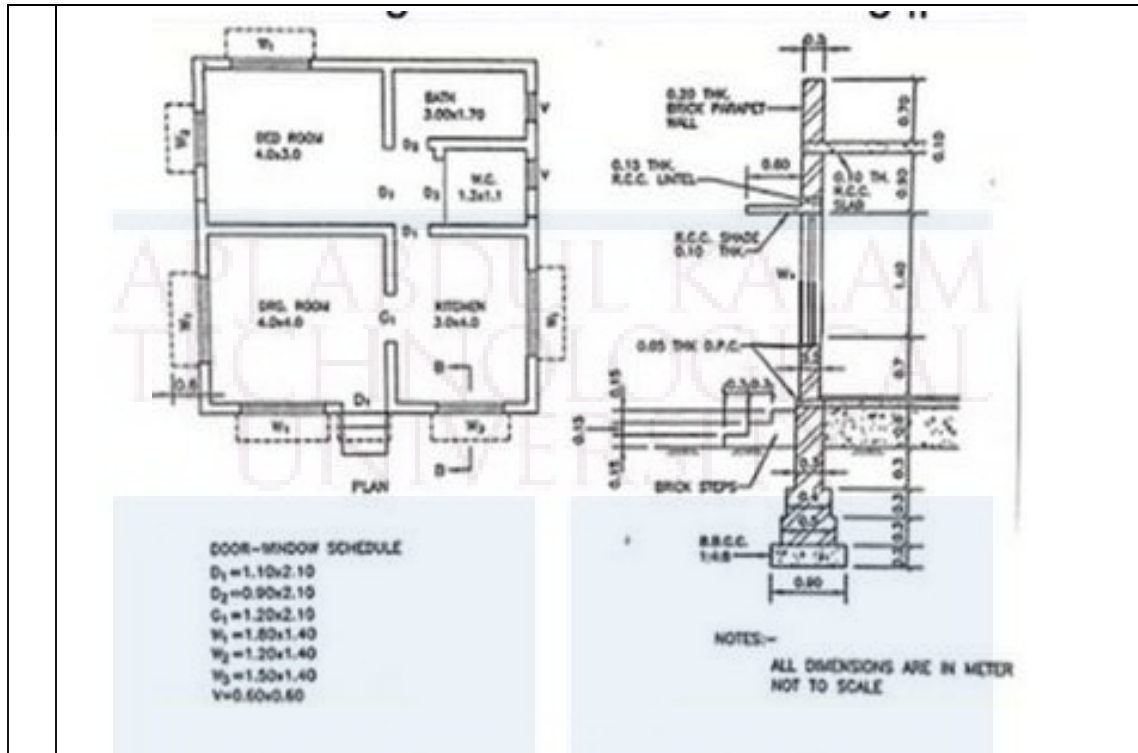
CO3: Prepare the approximate estimate of building

1.	Differentiate plinth area estimate and cubic content estimate
2.	<p>Prepare the approximate estimate of building project with total plinth area of all building is 800sqm from the following data</p> <ol style="list-style-type: none"> Plinth area rate₹. 45000 per sqm Cost of water supply @7.5% of cost of building Cost of sanitary and electrical installations each @ 7.5% of cost of building Cost of architectural features @ 1% of cost of building

<p>e) Cost of roads and lawns @5% of cost of building</p> <p>f) Cost of PS and contingencies @4% of cost of building</p> <p>Determine the total cost of building project</p>
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CO4: Prepare detailed estimates of buildings and the bar bending schedules for R.C.C works

1.	Explain bar bending schedule. State its uses
2.	Write the unit of measurement of (i) Carpentry fittings (ii) Pointing of Brick wall
3.	<p>Calculate the quantity of RCC and Prepare a bar bending schedule of the slab of size 330cm x 550cm (internal dimensions) shown in the figure. (All dimensions are in centimeters)</p> 
4.	<p>Prepare detailed estimate for the following items of work for the construction of residential building shown below</p> <ol style="list-style-type: none"> RRM for foundation and basement RCC works Inside and outside plastering



C05: Describe various principles and methods of valuation

1.	Explain how depreciation in building is worked out.
2.	Discuss about the different types of values and the term obsolescence
3.	Discuss the importance of valuation in civil engineering.

C06: Calculate the value of buildings by different methods

1.	A building is situated by the side of a main road of Mumbai city on a land of 500sqm. The built up portion is 20m x 15 m. The building is first class type and provided with water supply, sanitary and electrical fittings, and the age of the building is 30 years. Workout the valuation of the property.
2.	A three storied building is standing on a plot of land measuring 800sqm. The plinth area of each storey is 400sqm. There is an RCC framed structure and the future life may take as 70 years. The building fetches a gross rent of ₹.18000 per month, Work out the capitalized value of the property on the basis of 6% net yield. For sinking fund 3% compound interest may be assumed. Cost of the land may be taken as ₹. 10000 per sqm. The other data may assume suitably

3.	Workout the valuation of a commercial building with the following data: Cost of land for life-time period of building is ₹.5,20,000/-. Gross income per year is ₹.8,50,000/-Expenses required per year: (a) staff salary, electric charges, municipal taxes including licenses fees, stationery and printing etc. is 20% of the gross income. (b) For repair and maintenance of lift, furniture etc. @ 5% of their capital cost of ₹.10,50,000/- (c) sinking fund for the items considered in capital cost, whose life is 25years @4% after allowing 10% scrap value. (d) Insurance premium is ₹.25, 000/- per year. Take year's purchase @8% and annual repair of the building @2% on gross income.
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SYLLABUS

MODULE 1. General introduction- Quantity surveying- Basic principles, Types of Estimates- purposes, Specifications-General & detailed specification for building materials and execution of major item of work (Earth work excavation, masonry, concrete, finishing) of building work with reference to CPWD specifications-Method of measurement with reference to IS1200.

MODULE 2. Analysis of rates, Introduction to the use of CPWD schedule of rates as per latest DSR and Analysis of rate as per latest DAR, Overhead charges. Analysis of rates for Earth work in excavation for foundation, mortars, reinforced cement concrete Works, finishing work, masonry work, stone works, flooring with reference to latest DSR and latest DAR .Types of tender, contracts, General and important conditions of contract, contract document(concept only). Duties and roles of client, architect/engineer, contractor and local bodies.

MODULE 3. Detailed Estimate- Preparation of detailed measurement and abstract of estimate using Centreline method & Long wall short wall(separate wall) method for RCC single storey building, (students may answer the question by using any of the two methods)Septic tank and Soak Pit, preparation of Bar Bending Schedule– lintel, beams, slabs, RCC column footings.

MODULE 4. Valuation – explanation of different technical terms, purpose. Depreciation – methods of calculating depreciation – straight line method, constant percentage method, sinking fund method and quantity survey method, obsolescence.

Principles of valuation of open land- comparative method, abstractive method, belting method, valuation based on hypothetical building schemes. Methods of valuation of land with building – rental method, direct comparison of capital cost, valuation based on profit, depreciation method. Free hold and leasehold properties, Forms of rent, Rent fixation- Methods.

Text Books:

1. B. N. Dutta, Estimation and Costing in Civil Engineering, UBS publishers
2. Rangwala, Estimation Costing and Valuation, Charotar publishing house pvt. ltd
3. Dr. S. Seetha Raman, M.Chinna Swami, Estimation and Quantity Surveying, Anuradha publications Chennai.
4. M Chakraborty, Estimating, Costing, Specification and valuation, published by the author, 21 B, Babanda Road, Calcutta 26

References:

1. B S Patil, Civil Engineering Contracts and Estimates, university press
2. V N Vazirani & S P Chandola, Civil Engineering Estimation and Costing, Khanna Publishers
3. IS 1200-1968; Methods of Measurement of Building & Civil Engineering Works
4. CPWD DAR 2018 and DSR 2018 or latest

Lecture Plan

Module	Topic	Course Outcomes addressed	No. of Lectures
1	Module I: Total lecture hours: 7		
1.1	Introduction, estimation, purpose of estimation	CO3	1
1.2	Types of estimates, simple problems of approximate estimate	CO3	2
1.3	Specification, objectives, principles of specification writing, design of ideal specification	CO1	1
1.4	Types of specifications	CO1	1
1.5	Detailed specification of excavation, PCC & RCC, mortars, brick works.	CO2	2
2	Module II: Total lecture hours: 6		
2.1	Analysis of rate, need, factors affecting, Introduction to the use of CPWD DSR and DAR, overhead charges	CO2	1
2.2	Analysis of rates for earth works, PCC, RCC Works, finishes, masonry works, stone works, flooring, with reference to latest DSR and DAR. (Required data for rate analysis will be provided in the question paper.)	CO2	3

2.3	Tender, types, Contract,types,factors affecting, contract document, General and important conditions of contract.Duties and roles of client, architect/engineer, contractor and local bodies	CO2	2
3	Module III: Total lecture hours: 16		
3.1	Different methods of detailed estimation- center line method and long wall short wall method.	CO4	2
3.2	Preparation of detailed measurement and abstract of estimatefor RCC single storey buildings-Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, Flooring, Woodwork.	CO4	8
3.3	Estimation of Septic tank and soak pit	CO4	2
3.4	BBS of lintel, beam, slab and column footing	CO4	4
4	Module IV: Total lecture hours:16		
4.1	Valuation-purpose, different forms of values	CO5	1
4.2	Capitalized value, years purchase, sinking fund, Gross income, net income, outgoings –simple problems	CO5	3
4.3	Depreciation – methods of calculating depreciation – straight line method, constant percentage method, sinking fund method, and quantity survey method-problems,obsolescence	CO5	3
4.4	Methods of valuation of open land – comparative method, abstractive method, belting method, valuation based on hypothetical building schemes-Problems based on this	CO5,CO6	3
4.5	Methods of valuation of land with buildings – rental method, direct comparison with capital cost, valuation based on profit, depreciation method-Problems based on this	CO5,CO6	4
4.6	Free hold and leasehold properties, Forms of rent, Rent fixation- Methods. Simple problems based on this	CO6	2

MODEL QUESTION PAPER

Reg.No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**SIXTH SEMESTER B.TECH. DEGREE EXAMINATION****Course Code: CET382****Course Name: ESTIMATION, COSTING AND VALUATION**

Max.Marks:100

Duration: 3Hours

PART A*Answer all questions; each question carries 3 marks. (10×3 marks = 30 marks)*

1.
 - a) Differentiate revised estimate and supplementary estimate
 - b) What are the principles of specification writing?
 - c) Explain the use of data book and schedule of rates
 - d) What are the important points to be noted while preparing contract document?
 - e) In a simply supported beam of depth 450mm is provided with a 3, 20mm diameter bar at bottom, in this one bar is provided as bendup bar near both the supports. 10mm stirrups are provided with top and bottom cover 25mm. Calculate the additional length provided for bend up in both end. If the (i) bendup angle is 45° and (ii) bendup angle is 30° .
 - f) Write the unit of measurement of (i) DPC using waterproofing compound (ii) Iron work for window (iii) Water proof Painting above roof slab
 - g) Differentiate book value and market value
 - h) Differentiate depreciation and obsolescence
 - i) Explain how will you find out the valuation of land by hypothetical building scheme
 - j) Explain the depreciation method of valuation

PART B*Answer one full question from each module (Assume any missing data suitably)***Module I**

2.
 - a) Prepare approximate estimate of a public building having plinth area equal to 1800 sq.m.

- i. Plinth area rate as ₹. 35,000 / sq. m.
 - ii. Special architectural treatment = 3% of cost of building.
 - iii. Water supply and sanitary installation = 5% of cost of building.
 - iv. Electric installation = 14% of cost of building.
 - v. Other services = 5% of cost of building.
 - vi. Contingencies = 3% of overall cost of building.
 - vii. Supervision charges = 8% of overall cost of building. (10marks)
- b) Differentiate detailed estimate and preliminary estimate. What are the documents to be accompanied with detailed estimate? (6marks)

OR

3. Differentiate general specification and detailed specification with suitable example (16marks)

Module II

4. a) What are the factors affecting the rate of a particular item of work. (6 marks)
- b) Develop unit rate analysis for Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level 1:1½:3 (1 Cement: 1½ coarse sand (zone-III) : 3 graded stone aggregate 20 mm nominal size)

Details of cost for 1 cum.

MATERIAL: Stone Aggregate (Single size) 20 mm nominal size $0.57 \text{ m}^3 @ ₹1350/\text{m}^3$, Stone Aggregate (Single size): 10 mm nominal size $0.28 \text{ m}^3 @ ₹1350/\text{m}^3$, Coarse sand (zone III) $0.425 \text{ m}^3 @ ₹1350/\text{m}^3$, Portland Cement (0.2833 cum) 0.40 tonne @ ₹4940/tonne

LABOUR: Mason (average) 0.1/day @ ₹709/day, Beldar 1.63/day @ ₹558/day, Bhisti 0.70/day @ ₹617/day

HIRE CHARGES: Concrete Mixer 0.25 to 0.40 cum with hooper 0.07/day @ ₹800/day
Vibrator (Needle type 40mm) 0.07/day @ ₹370/day

CARRIAGE CHARGES: Stone aggregate below 40 mm nominal size $0.85 \text{ m}^3 @ ₹103.77/\text{m}^3$, Coarse sand $0.425 \text{ m}^3 @ ₹103.77/\text{m}^3$, Portland cement 0.40 tonne @ ₹92.24/tonne

Sundries: 14.3LS @ ₹2.00/LS (10marks)

OR

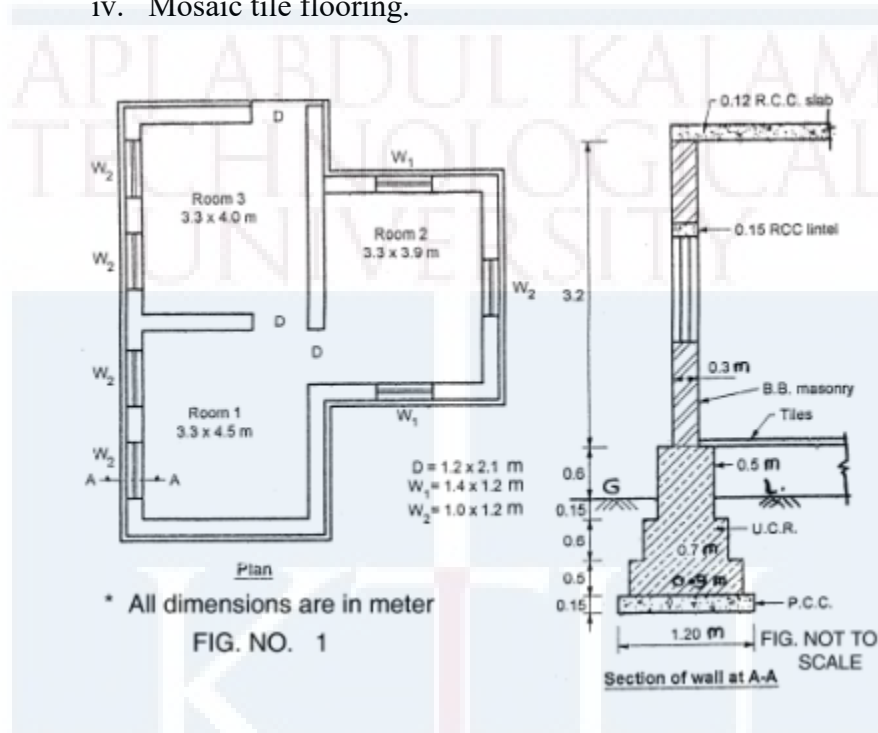
5. a. Explain the different types of contracts (8 marks)
- b. What are the general and important conditions of contract? (8 marks)

Module III

6. Prepare the detailed estimate of the following items of the building. Refer Fig. No. 1

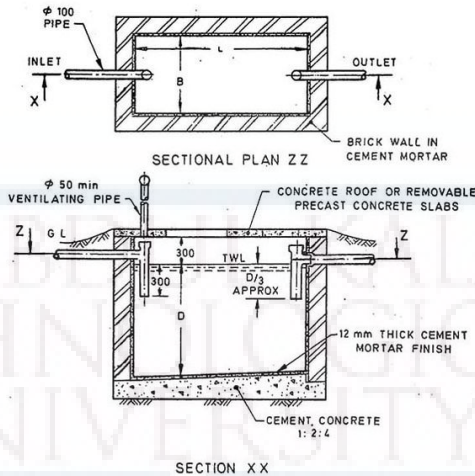
(22 marks)

- i. Excavation for foundation.
- ii. RR masonry in foundation and plinth (1:6)
- iii. Brick Masonry in superstructure (1:6).
- iv. Mosaic tile flooring.



OR

7. Prepare the detailed estimate of following items of septic tank shown below (22 marks)
- a) Earth work in excavation
 - b) Cement concrete 1:2:4
 - c) R.C.C work 1:1 ½:3
 - d) Plastering in C.M 1:3
 - e) Brick masonry



Module IV

8. a) A concrete mixer was purchased at ₹.8000/-. Assuming salvage value to be ₹.1000, after 5 years, calculate depreciation for each year adopting (a) Straight line method (b) Constant percentage method and (c) Sinking fund method considering 6% interest. (8 marks)
- b) A lease-hold property is to produce a net income of ₹.1,20,000/- per annum for the next 60 years. What is the value of the property? Assume that the land lord desires a return of 6% on his capital and the sinking fund to replace the capital is also to accumulate at 6%. What will be the value of the property if the rate of interest for redemption of capital is 3%? (8 marks)

OR

9. a) A property consists of a south facing plot of land, having south-east and north sides in due directions, which measures 60m, 180m and 80m respectively. It consists of an old two storied building, having a total cubical content of 2840 cubic metres. Assuming prime cost of construction of the building as ₹.20000/- per cubic metre and allowing 10% old materials value only for the building, what would you recommend as the fair value of the property, if the front belt land (depth of front belt being 25m) be estimated at ₹.9000/- per sqm? (8 marks)
- b) The owner of a building gets a net annual rent of ₹.85,500. The future life of building is estimated to be 12 years. But if recommended repairs are carried out immediately at an estimated cost of ₹.3, 00,000, it is expected to last for at least 30 years. Assuming rate of interest as 8%, determine whether it is economical to carry out the recommended repairs to the building or leave it as it is. (8 marks)

CET 384	GEOTECHNICAL INVESTIGATION & GROUND IMPROVEMENT TECHNIQUES	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	4	0	0	4	2019

Preamble: Goal of this course is to expose the students to various methods of soil exploration, to recognize weak soils based on the soil investigation reports and to analyze suitable remedial measures to improve the properties of weak soils. After this course, students will be able to recognize practical problems in real-world situations and respond accordingly.

Prerequisite : CET283 Introduction to Geotechnical Engineering

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

CO 1	Understand soil exploration methods
CO 2	Explain different methods of ground improvement techniques with and without addition of other materials
CO 3	List various types, functions and practical applications of Geosynthetics
CO 4	Describe the application of reinforcement function of geosynthetics in retaining structures like Reinforced Earth Retaining Walls, Gabions and Soil nailing
CO 5	Solve the field problems related to geotechnical engineering by applying ground improvement techniques

Mapping of course outcomes with program outcomes (Minimum requirement)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	-	-	-	-	-	-
CO 3	3		-	-	-	-	-	-	-	-	-	-
CO 4	2	3	-	-	-	-	-	-	-	-	-	-
CO5	2	2	3									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	20	20	40
Understand	20	20	40
Apply	10	10	20
Analyse			
Evaluate			

Mark Distribution

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

Continuous Internal Evaluation (CIE) Pattern :

Attendance	: 10 Marks
Continuous Assessment Test (2 numbers)	: 25 Marks
Assignment/Quiz/Course project	: 15 Marks

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

Course Level Assessment Questions

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

Course Outcome 1 (CO1):

1. Understand Soil Investigation and Soil Exploration methods

Course Outcome 2 (CO2):

1. Explain different methods of ground improvement techniques without addition of any materials viz. surface compaction & deep compaction
2. Explain different methods of ground improvement techniques with addition of other materials viz. grouting and lime stabilization

Course Outcome 3 (CO3):

1. List various types of Geosynthetics
2. List functions of Geosynthetics
3. List practical applications of Geosynthetics

Course Outcome 4 (CO4):

1. Explain reinforced earth retaining walls
2. Explain Gabions
3. Explain Soil Nailing

Course Outcome 5 (CO5):

1. Explain solutions of suitable ground improvement techniques for various practical situations

Module 1

Site investigation and soil exploration: Introduction and practical importance – objectives Planning of a sub-surface exploration program – Reconnaissance – Preliminary investigation - Detailed investigation - methods of subsurface exploration – direct methods - Open pits and trenches - Semi direct methods – Borings - Auger boring – Shell and Auger Boring - Wash boring, percussion drilling and rotary drilling – advantages and disadvantages -Guidelines for choosing spacing and depth of borings [I.S. guidelines only] - Sampling - disturbed samples, undisturbed samples and chunk samples - Types of samplers – Split spoon sampler – Thin-walled sampler – Piston sampler - Rotary sampler – Core Recovery and Rock Quality Designation

Module 2

Sounding and Penetration Tests - Standard Penetration Test – Procedure - Corrections to be applied to observed N values – Numerical examples - Factors influencing the SPT results and precautions to obtain reliable results – Merits and drawbacks of the test - Correlations of N value with various engineering and index properties of soils - Static Cone Penetration Test (SCPT) and Dynamic Cone Penetration Test (DCPT) – Brief Procedure - Merits/drawbacks - Boring log - soil profile- Location of Water table - Geophysical methods : Seismic Refraction method and Electrical Resistivity method – Brief Procedure - Merits/drawbacks

Module 3

Ground Improvement Techniques : Introduction – Objectives - Soil improvement without the addition of any material : Shallow and Deep Compaction - Shallow compaction – Rollers - Deep Compaction - Dynamic compaction - Compaction piles - Blasting technique - Vibro compaction– Vibroflotation - Terra probe method - Vibro replacement - sand piles and stone columns - Preloading techniques – sand drains

Module 4

Soil improvement by adding materials : Grouting – materials - Grouting systems : One shot and two shot systems - Modes of grouting - Main types of grouting : Permeation Grouting, Compaction Grouting and Jet Grouting – Practical Applications - Grouting Plant and equipment - Grouted columns – Curtain and blanket grouting – Practical applications - Lime stabilization –Mechanism- optimum lime content-lime fixation point

Module 5

Soil improvement using Geosynthetics : Materials of Geosynthetics - Types of Geosynthetics - Types of Geotextiles and Geogrids - Functions of Geosynthetics - Practical applications - Introduction to reinforced earth – principles – reinforcing materials - Reinforced earth retaining walls – components – construction sequence – practical applications - Gabions – Introduction - practical applications - Soil Nailing – Introduction – practical applications

Text Books:

1. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.
2. Purushotham S. Raju, Ground Improvement Technique, Laxmi Publications

References:

1. Shashi K. Gulhati and Manoj Dutta, Geotechnical Engineering, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008
2. Venkatramaiah, Geotechnical Engg, Universities Press, 2000.
3. Arora K. R., Geotechnical Engineering, Standard Publishers, 2006.
4. Moseley, Text Book on Ground Improvement, Blackie Academic Professional, Chapman & Hall, 2004
5. Boweven R., Grouting in Engineering Practice, Applied Science Publishers Ltd
6. Sivakumar Babu, G. L., An introduction to Soil Reinforcement and Geosynthetics, Universities Press (India) Private Limited, 2006
7. Jewell R.A., Soil Reinforcement with Geotextiles, CIRIA Special Publication, Thomas Telford
8. Donald .H. Gray & Robbin B. Sotir, Bio Technical & Soil Engineering Slope Stabilization, John Wiley
9. Rao G.V. & Rao G.V.S., Engineering with Geotextiles, Tata McGraw Hill
10. Korener, Construction & Geotechnical Methods In Foundation Engineering, McGraw Hill

Course Contents and Lecture Schedule:

CIVIL ENGINEERING

Module	Contents	Outcomes Addressed	Hours
1	Module 1		9
1.1	Site investigation and soil exploration: Introduction and practical importance - objectives	CO 1	1
1.2	Planning of a sub-surface exploration program – Reconnaissance – Preliminary investigation	CO 1	1
1.3	Detailed investigation - methods of subsurface exploration – direct methods - Open pits and trenches	CO 1	1
1.4	Semi direct methods – Borings - Auger boring – Shell and Auger Boring - Wash boring, percussion drilling and rotary drilling – advantages and disadvantages	CO 1	2
1.5	Guidelines for choosing spacing and depth of borings [I.S. guidelines only]	CO 1	1
1.6	Sampling - disturbed samples, undisturbed samples and chunk samples	CO 1	1
1.7	Types of samplers – Split spoon sampler – Thin-walled sampler – Piston sampler - Rotary sampler – Core Recovery and Rock Quality Designation	CO 1	2
2	Module 2		9
2.1	Sounding and Penetration Tests - Standard Penetration Test – Procedure	CO 1	1
2.2	Corrections to be applied to observed N values – Numerical examples	CO 1	1
2.3	Factors influencing the SPT results and precautions to obtain reliable results – Merits and drawbacks of the test	CO 1	1
2.4	Correlations of N value with various engineering and index properties of soils	CO 1	1
2.5	Static Cone Penetration Test (SCPT) and Dynamic Cone Penetration Test (DCPT) – Brief Procedure - Merits/drawbacks	CO 1	2
2.6	Boring log - soil profile- Location of Water table	CO 1	1
2.7	Geophysical methods : Seismic Refraction method and Electrical Resistivity method – Brief Procedure - Merits/drawbacks	CO 1	2
3	Module 3		9
3.1	Ground Improvement Techniques : Introduction - Objectives	CO 2	1
3.2	Soil improvement without the addition of any material : Shallow and Deep Compaction	CO 2	1

3.3	Shallow compaction - Rollers	CO 2	1
3.4	Deep Compaction - Dynamic compaction	CO 2	1
3.5	Compaction piles	CO 2	1
3.6	Blasting technique	CO 2	1
3.7	Vibro compaction– Vibroflotation - Terra probe method	CO 2	1
3.8	Vibro replacement - sand piles and stone columns - Preloading techniques – sand drains	CO 2	2
4	Module 4		9
4.1	Soil improvement by adding materials : Grouting - materials	CO 2	1
4.2	Grouting systems : One shot and two shot systems - Modes of grouting	CO 2	1
4.3	Main types of grouting : Permeation Grouting, Compaction Grouting and Jet Grouting – Practical Applications	CO 2 & CO 5	3
4.4	Grouting Plant and equipment	CO 2	1
4.5	Grouted columns – Curtain and blanket grouting – Practical applications	CO 2 & CO 5	1
4.6	Lime stabilization –Mechanism-optimum lime content-lime fixation point	CO 2	1
5	Module 5		9
5.1	Soil improvement using Geosynthetics : Materials of Geosynthetics	CO 3	1
5.2	Types of Geosynthetics - Types of Geotextiles and Geogrids	CO 3	1
5.3	Functions of Geosynthetics - Practical applications	CO 3 & CO5	1
5.4	Introduction to reinforced earth – principles – reinforcing materials	CO 4	1
5.5	Reinforced earth retaining walls – components – construction sequence – practical applications	CO 4 & CO5	2
5.6	Gabions – Introduction - practical applications	CO 4 & CO5	1
5.7	Soil Nailing – Introduction – practical applications	CO 4 & CO5	1

QP CODE:

Reg No.: _____

Name: _____

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

Course Code: **CET 384**

**Course Name : GEOTECHNICAL INVESTIGATION & GROUND IMPROVEMENT
TECHNIQUES**

Max. Marks: 100

Duration: 3 hours

Part A

(Answer all questions; each question carries 3 marks)

1. Explain Objectives of soil exploration
2. List out the factors, which affect the spacing between the bore holes
3. Discuss the merits and demerits of SPT in the sub-surface investigation
4. Discuss any one method of determining the ground water table.
5. Explain Compaction piles in sand
6. Explain Significant depth of influence in Deep compaction.
7. Explain One Shot system and two shot system in grouting
8. Explain optimum lime content and lime fixation point
9. Differentiate between Woven and Non-woven geotextiles.
10. Explain the principle of reinforced earth.

PART B

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

Module – 1

11. (a) Give guidelines, which enable the determination of the depth of exploration (5 Marks)
(b) Explain Wash boring methods of site exploration with neat sketch. What are the advantages and disadvantages of this method. (9 Marks)
12. (a) Distinguish between thin-wall and thick-wall samplers (5 Marks)
(b) Explain Auger boring and Shell & Auger boring methods of site exploration with neat sketches. What are the advantages of these methods. (9 Marks)

Module – 2

13. (a) Explain Static Cone Penetration Test. (5 Marks)
(b) What is Standard Penetration Test? Explain the test setup and the procedure of conducting the test. What are the corrections to the observed SPT (N) value? (9 Marks)
14. (a) Explain Dynamic Cone Penetration Test. (5 Marks)
(b) Explain Seismic Refraction Method of exploration. What are its limitations? (9 Marks)

Module – 3

CIVIL ENGINEERING

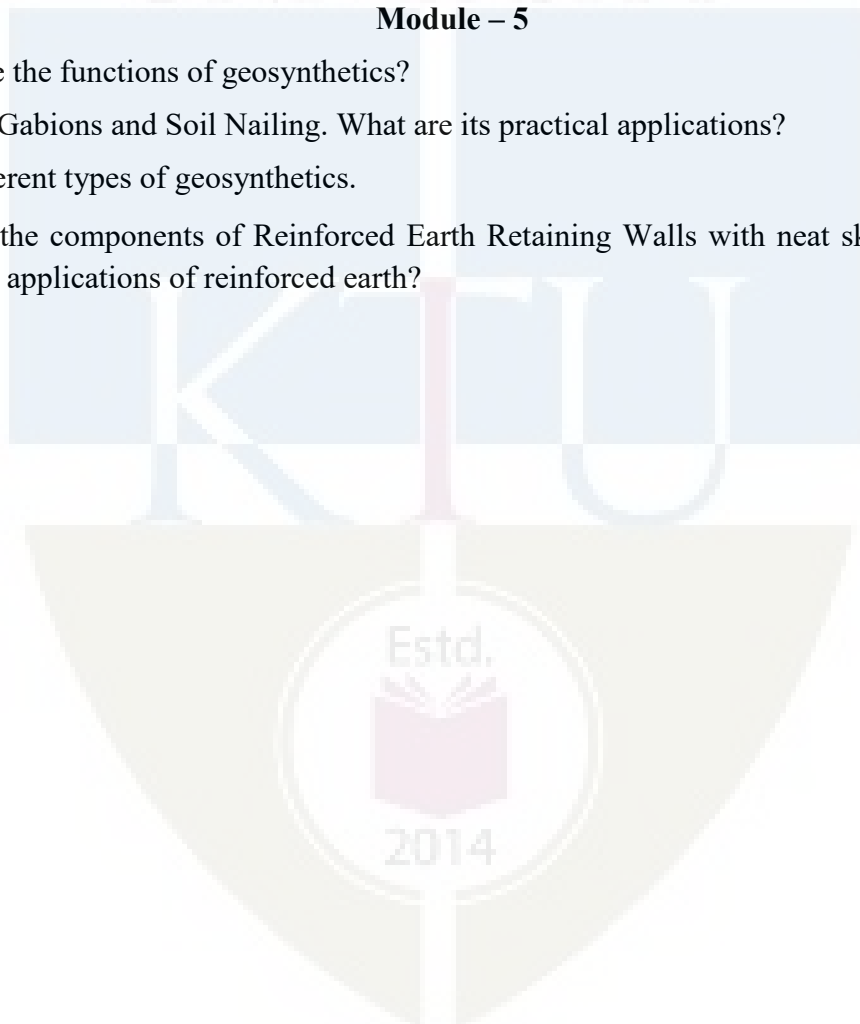
15. (a) Explain the dynamic compaction process for granular soils. (7 Marks)
(b) Explain Vibroflotation with neat sketch. What are the practical applications? (7 Marks)
16. (a) Explain Sand Piles and Stone Columns. (7 Marks)
(b) Explain Preloading Techniques with neat sketch. What are the advantages and disadvantages? (7 Marks)

Module – 4

17. (a) Explain Grouting Plant and Equipment (5 Marks)
(b) Explain Compaction Grouting. What are its practical applications? (9 Marks)
18. (a) Explain Lime stabilization method. (5 Marks)
(b) Explain jet grouting method. What are its practical applications? (9 Marks)

Module – 5

19. (a) What are the functions of geosynthetics? (5 Marks)
(b) Explain Gabions and Soil Nailing. What are its practical applications? (9 Marks)
20. (a) List different types of geosynthetics. (5 Marks)
(b) Explain the components of Reinforced Earth Retaining Walls with neat sketch. What are the practical applications of reinforced earth? (9 Marks)



CET 386	ENVIRONMENTAL HEALTH AND SAFETY	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	3	1	0	3	2019

Preamble: The course is designed to build environmental health literacy among students and encourages them to take safety measures against various environmental hazards. It motivates the students in maintaining and improving the quality of the environment and empower learners to take appropriate actions to reduce the environment pollution.

Pre-requisite: Nil

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

CO1	Understand the Toxicology and Occupational Health associated with industries.
CO2	Identify chemical and microbial agents that originate in the environment and can impact human health.
CO3	Describe various measures to ensure safety in Construction industry.
CO4	Explain the effect of air and water pollution on environment.
CO5	Describe the safety measures against various environmental hazards.

CET 386 Environmental Health And Safety		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	3					2	2							1	
	CO2	3					2	1								
	CO3	3					2	2								
	CO4	3					2	2								
	CO5	3					2	2								

Assessment pattern

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

Continuous Internal Evaluation Pattern:

Attendance	:	10marks
Continuous Assessment Test(2numbers)	:	25 marks
Assignment/Quiz/Course project	:	15marks
Total	:	50 marks

End semester examination pattern – There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment

Qn. No	Question	Marks	Course outcome (CO) Assessed
Part A			
1	What are the socio- economic reasons in safety?	3	CO1
2	Define industrial hygiene.	3	CO1
3	Define noise. What are the compensation aspects of noise?	3	CO2
4	Explain about the biohazard control program.	3	CO2
5	Discuss the possible electrical injuries in a construction industry.	3	CO3
6	What are the hazards due to radiation?	3	CO3
7	What are the criteria air pollutants?	3	CO4
8	Describe the Depletion of Ozone Layer.	3	CO4
9	What are the benefits of safety inspection?	3	CO5
10	Discuss the role of an individual in conservation of natural resources.	3	CO5

Part B (Answer ANY ONE FULL question from each module)			
Module I			
11	Briefly explain about occupational related diseases found in the industries.	14	CO1
12	Write the short notes on : (i) Silicosis (ii) Asbestosis (iii) Anthracosis (iv) Anthrax.	14	CO1
Module II			
13(a)	Write briefly about the classification of biohazardous agents.	7	CO2
13(b)	What are the precautionary measures for chemical hazards?	7	CO2
14	Write short notes on : (i) Vapour (ii) Fog (iii) Dust (iv) Fumes.	14	CO2
Module III			
15	Explain effects of radiation on human body and the methods of radioactive waste disposal.	14	CO3
16(a)	What are the requirements for safe work platform?	7	CO3
16(b)	Discuss about the scaffolding inspections.	7	CO3
Module IV			
17	Describe the effect of air pollution on environment.	14	CO4
18	Describe the effect of water pollution on environment.	14	CO4
Module V			
19 (a)	What is First aid? Explain CPR.	7	CO5
19 (b)	What are the important points to be considered in carrying out workplace inspection?	7	CO5
20 (a)	Explain the first aid measure to be taken during i) gas poisoning, ii) heart attack, iii) chemical splash and iv) electric shock.	10	CO5
20 (b)	Briefly explain the elementary first aid	4	CO5

Model Question Paper

CIVIL ENGINEERING

Reg.No.:.....

QP CODE:.....

Name:.....

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CET 386

Environment Health and Safety

Max. Marks: 100

Duration: 3 hours

Part A

(Answer all questions; each question carries 3 marks)

1. What are the socio- economic reasons in safety?
2. Define industrial hygiene.
3. Define noise. What are the compensation aspects of noise?
4. Explain about the biohazard control program.
5. Discuss the possible electrical injuries in a construction industry.
6. What are the hazards due to radiation?
7. What are the criteria air pollutants?
8. Describe the Depletion of Ozone Layer.
9. What are the benefits of safety inspection?
10. Discuss the role of an individual in conservation of natural resources.

Part B

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

Module I

11. Briefly explain about occupational related diseases found in the industries. (14 Marks)

OR

12. Write the short notes on : (14 Marks)

- (i) Silicosis
- (ii) Asbestosis
- (iii) Anthracosis
- (iv) Anthrax.

Module II

13. (a) Write briefly about the classification of biohazardous agents.(7 Marks)
(b) What are the precautionary measures for chemical hazards? (7 Marks)

OR

14. Write short notes on :(14 Marks)
(i)Vapour(ii) Fog (iii) Dust (iv) Fumes.

Module III

15. Explain effects of radiation on human body and the methods of radioactive waste disposal. (14 Marks)

OR

16. (a) What are the requirements for safe work platform? (7 Marks)
(b) Discuss about the scaffolding inspections.(7 Marks)

Module IV

17. Describe the effect of air pollution on environment. (14 Marks)

OR

18. Describe the effect of water pollution on environment.(14 Marks)

Module V

19. (a) What are the important points in carrying out workplace inspection?(7 Marks)
(b) What is First aid? Explain CPR. (7 Marks)

OR

20. (a) Explain the first aid measure to be taken during gas poisoning,(10 Marks)
heart attack, chemical splash and electric shock.
(b) Briefly explain the elementary first aid (4 Marks)

Course Code: CET 386
Environmental Health And Safety

Module I

Introduction to Occupational Health And Toxicology : Safety at work – Socio – Economic reasons. Introduction to health and safety at various industries. occupational related diseases-Musculoskeletal disorders, hearing impairment, carcinogens, silicosis, asbestosis, pneumoconiosis – Toxic materials and substances used in work, exposure limits, toxicological investigation, Industrial Hygiene, Arrangements by organisations to protect the workers.

Module II

Chemical hazards-dust, fumes, vapour, fog, gases, Methods of Control. **Biological hazards**- Classification of Biohazardous agents– bacterial agents, viral agents, fungal, parasitic agents, infectious diseases, control of biological agents at workplaces. Noise, noise exposure regulation and control.

Module III

Safety in Construction industry - Scaffolding and Working platform, Welding and Cutting, Excavation Work, Concreting, control measures to reduce the risk. Electrical Hazards, Protection against voltage fluctuations, Effects of shock on human body. Radiation Hazards, Types and effects of radiation on human body, disposal of radioactive waste.

Module IV

Air Pollution - air pollutants from industries, effect on human health, animals, Plants and Materials - depletion of ozone layer-concept of clean coal combustion technology.
Water Pollution - water pollutants-health hazards - effluent quality standards. Waste Management -waste identification, characterization and classification, recycling and reuse.

Module V

Safe working environment - The basic purpose and benefits of safety inspection, First-aid appliances, Shelters, rest rooms and lunch rooms, use of personal protective equipment, Role of an individual in conservation of natural resources, Methods for controlling water pollution, role of individual in prevention of pollution.

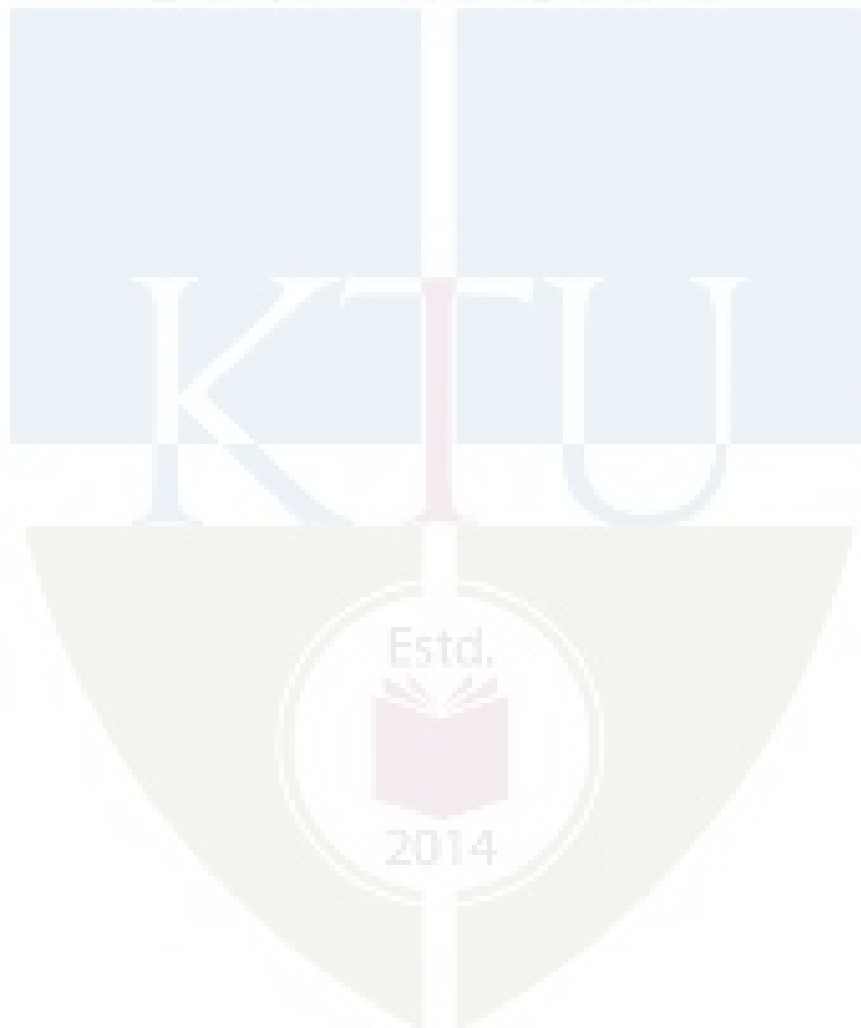
Text Books:

1. Environmental and Health and Safety Management by By Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995.
2. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services 2005.

3. The Facility Managers Guide to Environmental Health And Safety by Brian Gallant, Government Inst Publ., 2007.
4. R.K.Jain and Sunil S.Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi (2006).
5. Mackenzie L Davis, Introduction to Environmental Engineering, McGrawhill Education (India).

References:

1. Slote. L, Handbook of Occupational Safety and Health, JohnWilleyand Sons, NewYork.
2. Heinrich H.W, Industrial Accident Prevention, McGrawHillCompany,NewYork,1980.
3. S.P.Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993.



Environmental Health And Safety

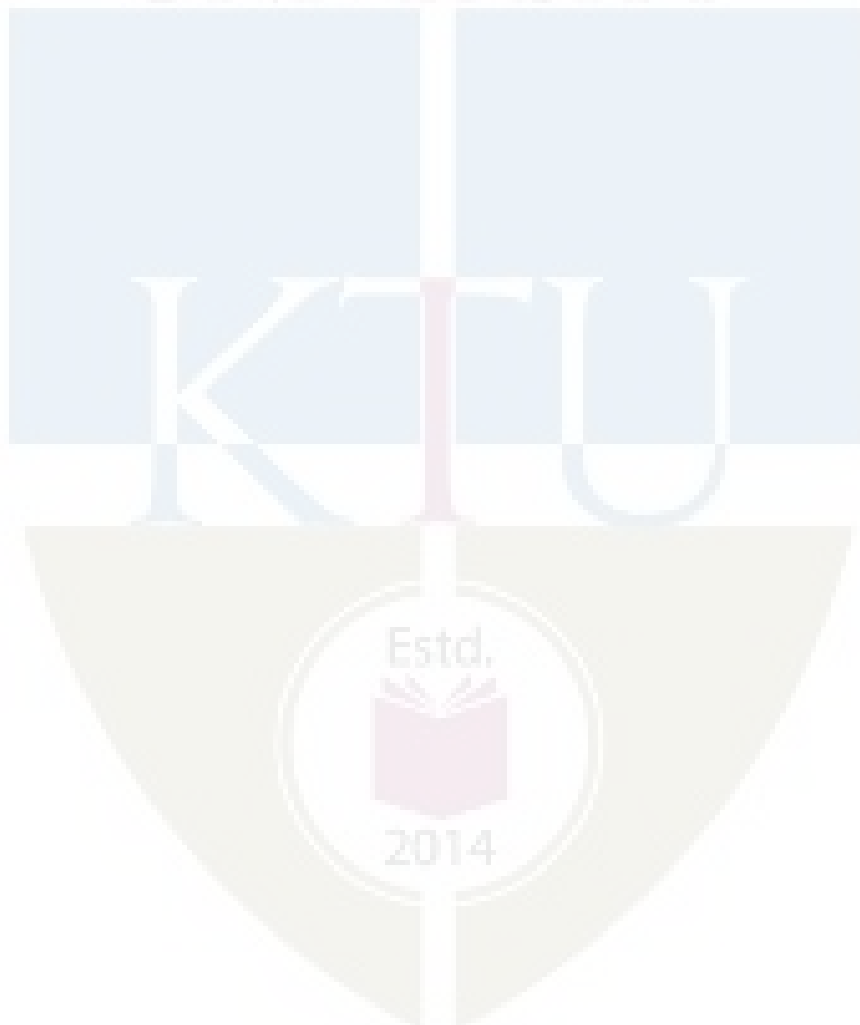
Course content and Schedule of Lecture (sample)

Module	Topic	Course outcome addressed	No of Hours
Module I (9 Hours)			
1.1	Introduction to Occupational Health And Toxicology.	CO1	1
1.2	Safety at work – Socio – Economic reasons.	CO1	1
1.3	Introduction to health and safety at various industries.	CO1	1
1.4	Occupational related diseases-Musculoskeletal disorders, hearing impairment	CO1	1
1.5	Occupational related diseases - carcinogens, silicosis, asbestosis, pneumoconiosis.	CO1	1
1.6	Toxic materials and substances used in work.	CO1	1
1.7	Exposure limits, toxicological investigation.	CO1	1
1.8	Industrial Hygiene.	CO1	1
1.9	Arrangements by organisations to protect the workers.	CO1	1
Module II (9 Hours)			
2.1	Chemical hazards.	CO2	1
2.2	Dust, fumes, vapour, fog, gases.	CO2	1
2.3	Methods of Control.	CO2	1
2.4	Biological hazards.	CO2	1
2.5	Classification of Biohazardous agents.	CO2	1
2.6	Bacterial agents, viral agents, fungal, parasitic agents, infectious diseases.	CO2	1
2.7	Control of biological agents at workplaces.	CO2	1
2.8	Noise.	CO2	1
2.9	Noise exposure regulation and control.	CO2	1

Module III (8 Hours)			
3.1	Safety in Construction industry- Scaffolding and Working platform.	CO3	1
3.2	Welding and Cutting, Excavation Work, Concreting.	CO3	1
3.3	Control measures to reduce the risk.	CO3	1
3.4	Electrical Hazards.	CO3	1
3.5	Protection against voltage fluctuations.	CO3	1
3.6	Effects of shock on human body, Radiation Hazards	CO3	1
3.7	Types and effects of radiation on human body.	CO3	1
3.8	Disposal of radioactive waste.	CO3	1
Module IV (9 Hours)			
4.1	Air Pollution - air pollutants from industries.	CO4	1
4.2	Effect on human health, animals.	CO4	1
4.3	Plants and Materials - depletion of ozone layer.	CO4	1
4.4	Concept of clean coal combustion technology.	CO4	1
4.5	Water Pollution - water pollutants.	CO4	1
4.6	Health hazards - effluent quality standards.	CO4	1
4.7	Waste Management-waste identification.	CO4	1
4.8	Characterization and classification.	CO4	1
4.9	Recycling and reuse.	CO4	1
Module V (8 Hours)			
5.1	Safe working environment.	CO5	1
5.2	The basic purpose and benefits of safety inspection.	CO5	1
5.3	First-aid appliances.	CO5	1
5.4	Shelters, rest rooms and lunch rooms.	CO5	1
5.5	Use of personal protective equipment.	CO5	1

5.6	Role of an individual in conservation of natural resources.	CO5	1
5.7	Methods for controlling water pollution.	CO5	1
5.8	Role of individual in prevention of pollution.	CO5	1

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SEMESTER VI

HONOURS



CET394	FINITE ELEMENT METHODS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: This course provides the fundamental concepts of finite element method and its applications in structural engineering. As a natural development from matrix analysis of structures learnt earlier, the student is encouraged to appreciate the versatility of this method across various domains, also as the basis of many structural analysis softwares. This course introduces the basic mathematical concepts of the method and its application to simple analysis problems.

Prerequisite: CET302 Structural Analysis II

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	Understand the basic features of boundary value problems and methods to solve them.	Remembering, Understanding
CO2	Understand the fundamental concept of the finite element method and develop the ability to generate the governing FE equations for systems governed by partial differential equations.	Understanding, Applying
CO3	Get familiar with the basic element types and shape functions so as to identify and choose suitable elements to solve a particular problem.	Analysing, Applying
CO4	Understand the concept of isoparametric elements and apply it for problems in structural engineering.	Understanding, Applying
CO5	Apply numerical integration procedures as a tool to solve mathematical models in FEM.	Understanding, Applying

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	05	05	10
Understand	10	10	20
Apply	20	20	40
Analyse	15	15	30
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

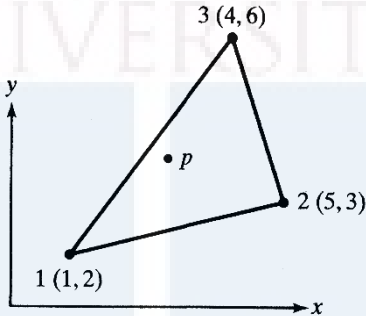

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

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

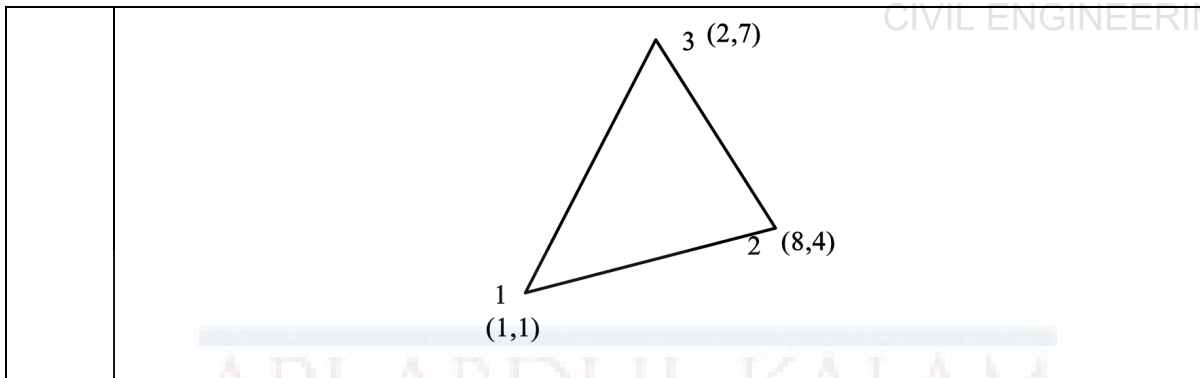
Course Level Assessment Questions

CO1:	Understand the basic features of boundary value problems and methods to solve them.
1.	What are boundary value problems? What are the physical and mathematical significances of boundary conditions in structural mechanics problems?
2.	Using the Galerkin method obtain an approximate solution to the following boundary value problem. $u''(x) + u(x) + x = 0 \quad 0 < x < 1$ $u(0) = 0 \quad u(1) = 0$ <p>(a) Assume a quadratic polynomial as a trial solution. (b) Assume a cubic polynomial as a trial solution.</p>
3.	Find a one-parameter approximate solution of the nonlinear equation $-2u \frac{d^2u}{dx^2} + \left(\frac{du}{dx} \right)^2 = 4 \quad \text{for } 0 < x < 1,$ <p>subject to the boundary conditions $u(0) = 1$ and $u(1) = 0$, and compare it with the exact solution $u = 1 - x^2$. Use the least-squares method.</p>

CO2:	Understand the fundamental concept of the finite element method and develop the ability to generate the governing FE equations for systems governed by partial differential equations.
1.	Derive the governing differential equation of a uniform bar subjected to axial vibrations.
2.	What are field variables and forcing vectors in finite element analysis? Give examples from various applications.
3.	Derive the element stiffness equations for an axial deformation problem, using variational approach.
4.	(a) Obtain the weak form of the following boundary value problem. $x^2 \frac{d^2u}{dx^2} + 2x \frac{du}{dx} - xu + 4 = 0 \quad 1 < x < 3$ $u(1) = 1 \quad \frac{du(3)}{dx} - 2u(3) = 2$ <p>(b) With the weak form obtained in (a), use Rayleigh-Ritz method to obtain an approximate solution of the above BVP. Use a linear polynomial trial solution.</p>

CO3:	Get familiar with the basic element types and shape functions so as to identify and choose suitable elements to solve a particular problem.
1.	What are shape functions? What are their advantages in finite element analysis?
2.	Obtain the shape functions for a 4-noded bar element using Lagrange polynomials.
3.	Write the elasticity relations for axisymmetric elements.
4.	For the CST element in figure, x-coordinate at P is 3 and N2 is 0.4 at P. Determine: (a) the y-coordinate at P (b) N1 and N3 at P.
	
5.	Get the explicit shape functions for the rectangular element shown in Figure 3, using Lagrange formulae.
	

CO4:	Understand the concept of isoparametric elements and apply it for problems in structural engineering.
1.	Find the axial deformation of a mild steel square bar of side 3cm and length 2m, using two linear isoparametric axial elements.
2.	Derive the shape functions for an isoparametric Constant Strain Triangle element.
3.	Find the isoparametric mapping for the CST element shown.



- 4. What are the advantages of coordinate mapping?
- 5. What are superparametric, subparametric and isoparametric elements?
- 6. Illustrate the influence of node numbering on Jacobian, by using a linear triangular isoparametric element.

7. For the axisymmetric triangular elements in Figure, for the loaded edge,

(a) determine the nodal surface traction vector in x-direction.
 (b) determine the nodal surface traction vector in y-direction

CO5:	Apply numerical integration procedures as a tool to solve mathematical models in FEM.
1.	Evaluate the following integrals using Gauss quadrature: $(a) I = \int_{0.2}^{0.8} e^{-2x} \tan x dx \quad (b) I = \int_{-2}^2 \frac{dx}{1+x^2}$ $(c) I = \int_{-1}^1 \int_{-1}^1 (t^3 + s^2) ds dt \quad (d) I = \int_{-1}^1 \int_{-1}^1 x \sin(x + y^2) dx dy$
2.	What are the essential features of numerical integration using Gauss quadrature?
3.	Obtain the two-point Gauss quadrature points and weights from first principles
4.	How to determine the number of Gauss points to evaluate an integral exactly?

MODULE I – 9 hrs.

Introduction - Boundary value problems; Introduction to approximate numerical solutions for solving differential equations.

MODULE II – 9 hrs.

Formulation techniques: Element equations using variational approach- Element equations using weighted residual approach - the axial element example.

MODULE III – 9 hrs.

Basic elements: Interpolation and shape functions – convergence requirements; CST, LST, bilinear rectangular elements, solid elements.

MODULE IV – 9 hrs.

Isoparametric Formulation: coordinate mapping - One dimensional bar element; Two dimensional isoparametric elements - CST, LST, bilinear quadrilateral elements - Plain stress, plain strain problems.

MODULE V – 9 hrs.

Development of stiffness matrix for *beam elements*; Introduction to *higher order* elements; Introduction to *axisymmetric* elements.

Numerical Integration: Gauss quadrature

Text Books:

1. Desai, C.S., Elementary Finite Element Method, Prentice Hall of India.
2. Chandrupatla, T.R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India.

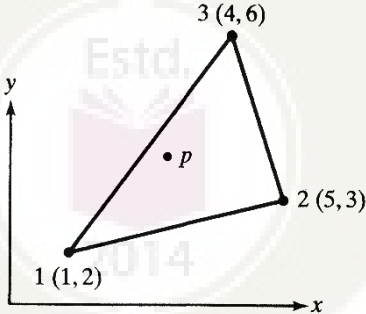
References:

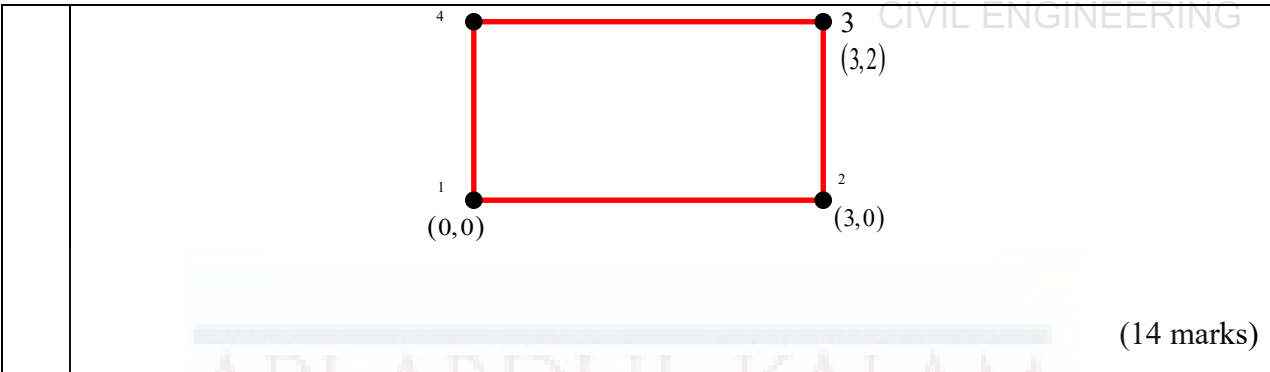
1. Cook, R.D., et al, Concepts and Applications of Finite Element Analysis, John Wiley.
2. Bathe, K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall of India.
3. Gallagher, R.H., Finite Element Analysis: Fundamentals, Prentice Hall Inc.
4. Rajasekaran, S., Finite Element Analysis in Engineering Design, Wheeler Pub.
5. Krishnamoorthy, C.S., Finite Element Analysis Theory and Programming, Tata McGraw Hill.
6. Zienkiewicz, O.C., and Taylor, R.L., The Finite Element Method, Vol. I and II, McGraw Hill.
7. Bhatti, Asghar, Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations

Lecture Plan –Structural Analysis II

Module	Topic	Course Outcomes addressed	No. of Lectures
1	Module I: Total lecture hours: 9		
1.1	General introduction – brief review of matrix methods, applications and versatility of FEM	CO1	1
1.2	Introduction to Boundary value problems; approximate numerical solutions for solving differential equations - Least squares method	CO1	3
1.3	Collocation method, Galerkin method - examples	CO1	5
2	Module II: Total lecture hours: 9		
2.1	Formulation techniques: Variational approach and weighted residual approach – initial concepts and differences	CO2	1
	Element equations using variational approach		3
2.2	Element equations using weighted residual approach	CO2	3
2.3	The axial element example in detail	CO2, CO3	2
3	Module III: Total lecture hours: 9		
3.1	Basic elements: Interpolation and shape functions	CO3	2
3.2	Convergence requirements; CST element	CO3	3
3.3	LST, bilinear rectangular elements, solid elements.	CO3	4
4	Module IV: Total lecture hours: 9		
4.1	Isoparametric Formulation: coordinate mapping - One dimensional bar element	CO4	2
4.2	Two dimensional isoparametric elements – CST element	CO4	3
4.3	LST, bilinear quadrilateral elements - Plain stress, plain strain problems.	CO4	4
5	Module V: Total lecture hours: 9		
5.1	Development of stiffness matrix for beam elements	CO3, CO4	2
5.2	Introduction to higher order elements	CO3, CO4	2
5.3	Introduction to axisymmetric elements.	CO3, CO4	2
5.4	Numerical Integration: Gauss quadrature	CO5	3

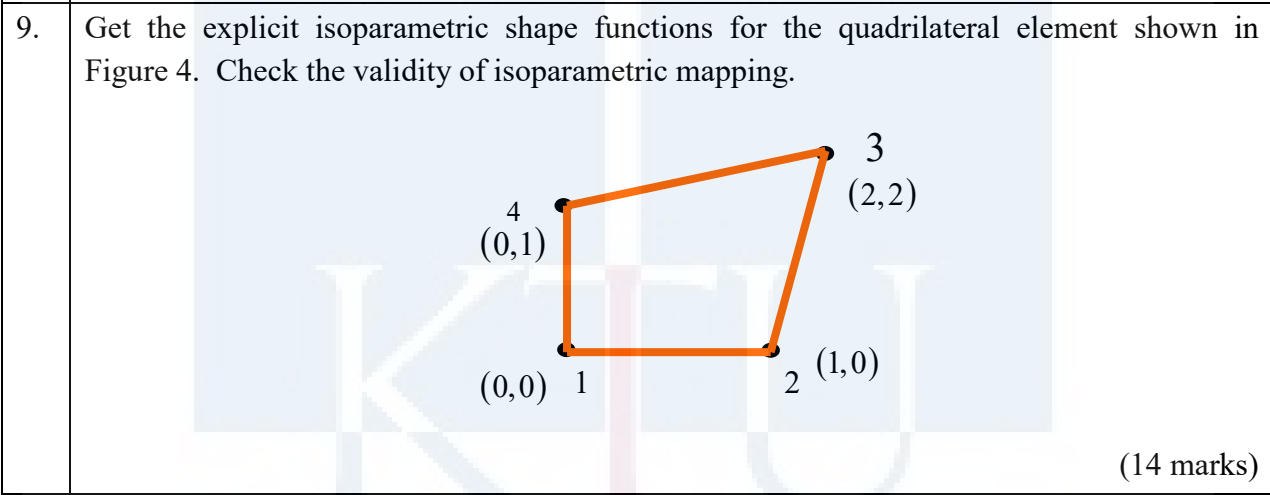
Reg.No.: _____		Name: _____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY SIXTH SEMESTER B.TECH DEGREE EXAMINATION			
Course Code: CET394			
Course Name: FINITE ELEMENT METHODS			
Max. Marks: 100		Duration: 3 Hours	
PART A			
<i>Answer all questions; each question carries 3 marks.</i>			
1.	a)	What are field variables and forcing vectors in finite element analysis? Give examples from various applications.	
	b)	What are boundary value problems? What are the physical and mathematical significances of boundary conditions in structural mechanics problems?	
	c)	List the essential properties of shape functions.	
	d)	Briefly explain the essential features of weighted residual methods to solve partial differential equations.	
	e)	Write down the brief general procedure in finite element analysis.	
	f)	What are shape functions? What are their advantages in finite element analysis?	
	g)	What are the advantages of coordinate mapping?	
	h)	What are superparametric, subparametric and isoparametric elements?	
	i)	What are axisymmetric elements? Explain.	
	j)	How to determine the number of Gauss points to evaluate an integral exactly?	
(10×3 marks = 30 marks)			
PART B			
<i>Answer one full question from each module; each full question carries 14 marks.</i>			
Module I			
2.	Using the Galerkin method obtain an approximate solution to the following boundary value problem. $u''(x) + u(x) + x = 0 \quad 0 < x < 1$ $u(0) = 0 \quad u(1) = 0$ <p>(a) Assume a quadratic polynomial as a trial solution. (b) Assume a cubic polynomial as a trial solution.</p> <p style="text-align: right;">(2×7=14 marks)</p>		
3.	Find a one-parameter approximate solution of the nonlinear equation		

	<p style="text-align: right;">CIVIL ENGINEERING</p> $-2u \frac{d^2u}{dx^2} + \left(\frac{du}{dx} \right)^2 = 4 \quad \text{for } 0 < x < 1,$ <p>subject to the boundary conditions $u(0) = 1$ and $u(1) = 0$, and compare it with the exact solution $u = 1 - x^2$. Use the least-squares method.</p> <p style="text-align: right;">(14 marks)</p>
Module II	
4.	<p>Derive the element stiffness equations for an axial deformation problem, using variational approach.</p> <p style="text-align: right;">(14 marks)</p>
5.	<p>(a) Obtain the weak form of the following boundary value problem.</p> $x^2 \frac{d^2u}{dx^2} + 2x \frac{du}{dx} - xu + 4 = 0 \quad 1 < x < 3$ $u(1) = 1 \quad \frac{du(3)}{dx} - 2u(3) = 2$ <p>(b) With the weak form obtained in (a), use Rayleigh-Ritz method to obtain an approximate solution of the above BVP. Use a linear polynomial trial solution.</p> <p style="text-align: right;">(2×7=14 marks)</p>
Module III	
6.	<p>For the CST element in figure, x-coordinate at P is 3 and N2 is 0.4 at P. Determine:</p> <p>(a) the y-coordinate at P</p> <p>(b) N1 and N3 at P.</p> <div style="text-align: center;">  </div> <p style="text-align: right;">(2×7=14 marks)</p>
7.	<p>Get the explicit shape functions for the rectangular element shown in Figure 3, using Lagrange formulae.</p>

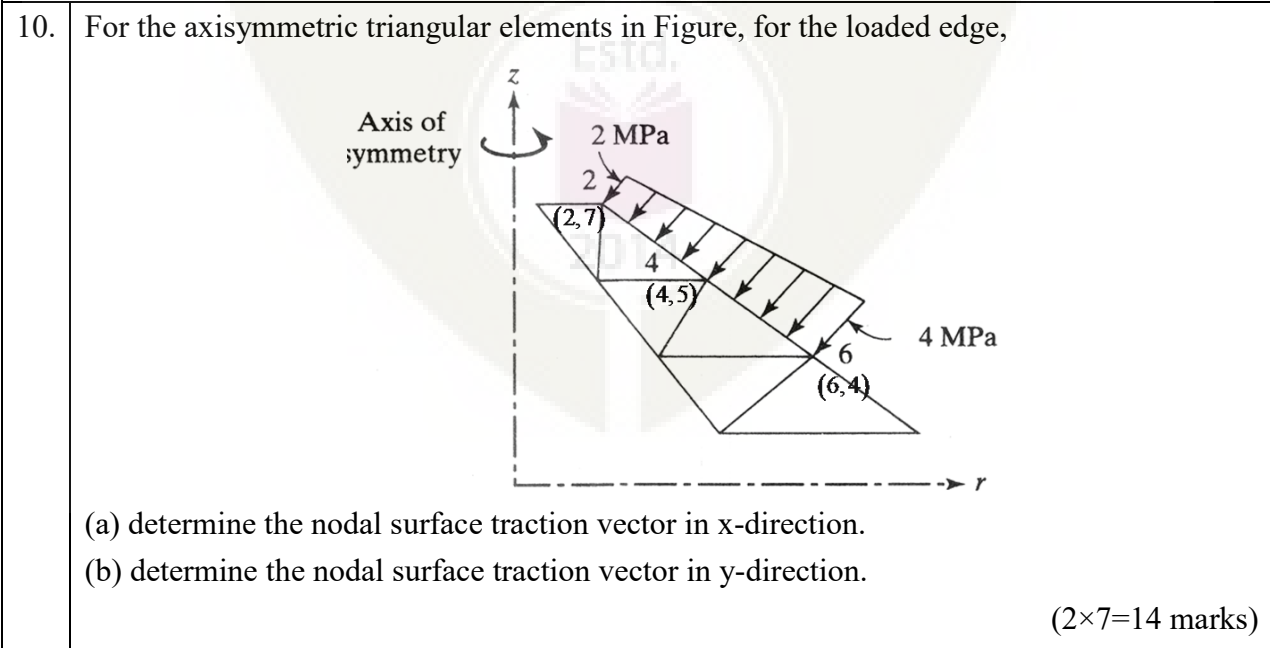


Module IV

8. Illustrate the influence of node numbering on Jacobian, by using a linear triangular isoparametric element. (14 marks)



Module V

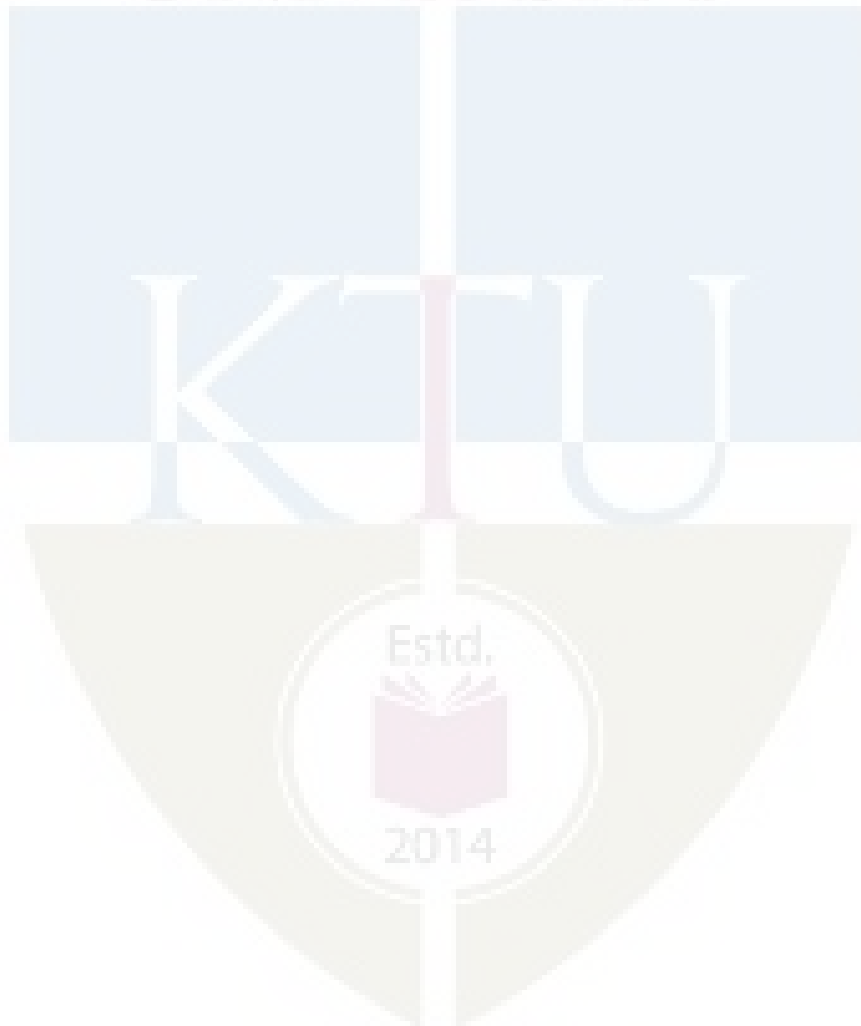


11. Evaluate the following integrals using two-point Gauss quadrature:

$$(a) I = \int_1^2 \int_4^6 xy e^{(x^2+y^2)} dx dy \quad (b) I = \int_{-2}^2 \frac{dx}{1+x^2}$$

(2×7=14 marks)

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

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

Prerequisite: CET 305 : GEOTECHNICAL ENGINEERING II

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

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

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

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

Mark Distribution

CIVIL ENGINEERING

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

Continuous Internal Evaluation (CIE) Pattern :

Attendance	: 10 Marks
Continuous Assessment Test (2 numbers)	: 25 Marks
Assignment/Quiz/Course project	: 15 Marks

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

Course Level Assessment Questions

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

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

1. Analyze slope stability of earth dams

Course Outcome 3 (CO3):

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

Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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

SYLLABUS

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

Text Books :

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

References:

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

Course Contents and Lecture Schedule:

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

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

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

Reg No.: _____

Name: _____

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

Course Code: CET396

Course Name : EARTH DAMS AND EARTH RETAINING STRUCTURES

Max. Marks: 100

Duration: 3 hours

Part A

(Answer all questions; each question carries 3 marks)

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

PART B

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

Module – 1

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

Module – 2

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

Module – 3

15. (a) Explain Trial wedge method of earth pressure. (5 Marks)
- (b) Compute the total lateral earth thrust exerted by a layered backfill of height 10m if the wall has a tendency to move away from the backfill. The upper layer of thickness 4 m has angle of internal friction 32° and unit weight 19 kN/m^3 . The lower layer has angle of internal friction 28° , cohesion 20 kPa , and unit weight 18 kN/m^3 . The backfill also supports a uniform surcharge of intensity 10 kN/m^2 . Also find the point of application. (9 Marks)
16. (a) Explain the importance of capillary tension in computation of earth pressure (5 Marks)
- (b) For a layered backfill behind a 10m high retaining wall with a smooth vertical backfill, Draw the active earth pressure distribution and its magnitude and point of application : (9 Marks)

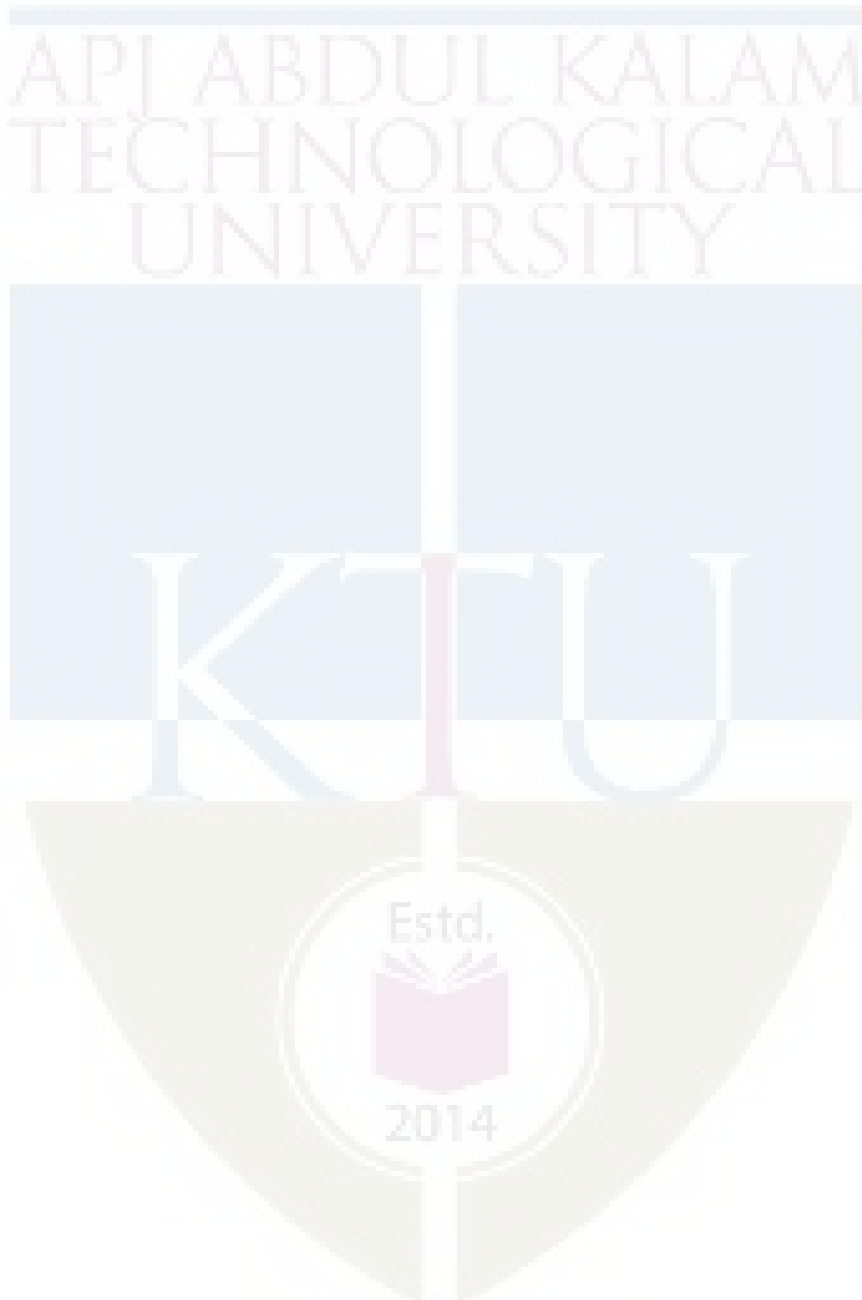
Sl. No.	Depth	Backfill Properties
1.	0 – 3 m	$c = 30 \text{ kN/m}^2, \phi = 0^\circ, \gamma = 19 \text{ kN/m}^3$
2.	3 – 6 m	$c = 0 \text{ kN/m}^2, \phi = 32^\circ, \gamma = 18 \text{ kN/m}^3$
3.	6 – 10 m	$c = 50 \text{ kN/m}^2, \phi = 0^\circ, \gamma = 17 \text{ kN/m}^3$

Module – 4

17. (a) Explain design strength parameters of a flexible retaining wall. (5 Marks)
- (b) The retaining wall having 6m height having back of wall is inclined at +ve batter angle of 15° and ground surface has an upward inclination of 20° retains a backfill with following properties : $\gamma = 19 \text{ kN/m}^3, \phi = 34^\circ, \delta = 20^\circ$.
- (i) Determine the total active thrust by Rebann's graphical construction.
- (ii) A surcharge of 50 kN/m^2 is acting on the backfill. What is the magnitude of total active thrust? (9 Marks)
18. (a) Explain Logarithmic Spiral method. (5 Marks)
- (b) A trapezoidal masonry retaining wall 1.5m wide at the top and 5m wide at its bottom is 5m high. The vertical face is retaining soil ($\phi = 30^\circ$) at a surcharge angle of 15° with the horizontal. Unit weights of soil and masonry are 20 kN/m^3 and 24 kN/m^3 . The coefficient of friction at the base of the wall is 0.40. Check the stability of the retaining by applying necessary checks if the soil bearing capacity is 90 kN/m^2 . (9 Marks)

Module – 5

19. (a) Explain the step by step procedure for design of a diaphragm wall. (7 Marks)
- (b) Describe the stability checking of sheet pile wall using fixed and free earth support methods. (7 Marks)
20. (a) What are different types of coffer dams? (5 Marks)
- (b) An anchored sheet pile is to support a mass of cohesion less soil up to height of 6m above ground level with horizontal anchor toes spaced at 1m intervals and located at 1.0m below the ground surface. If the unit weight of the soil is 21kN/m^3 and its angle of internal friction is 30° , determine the minimum depth of embedment of the sheet pile for stability. (9 Marks)



CET 398	ENVIRONMENTAL POLLUTION MODELLING	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	3	1	0	4	2019

Preamble : This course introduces various approaches for environmental pollution modeling. Students will learn how to develop a verified and validated model. The mathematics behind various environmental pollution models with their uncertainties will be discussed.

Prerequisite: NIL

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	To appreciate the mathematical modelling approach	Understanding
CO2	To learn how to build a model to represent physical transport of pollutants in environment	Understanding, Applying
CO 3	To simulate pollution transport scenarios in water, air and noise environment	Applying , Analysing
CO 4	To interpret the modelling results for decision support	Analysing

Mapping of course outcomes with program outcomes (Minimum requirement)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	2	-	2	-	-	-	-	-	-	-	-
CO4	-	2	-	2	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	15
Understand	10	10	15
Apply	15	15	35
Analyse	15	15	35
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

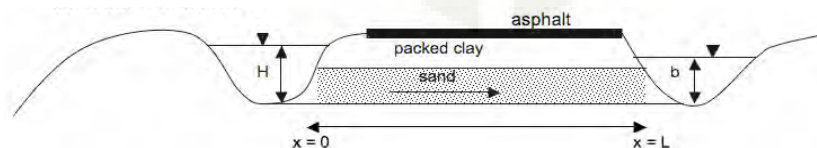
Attendance : 10 marks
 Continuous Assessment Test (2 numbers) : 25 marks
 Assignment/Quiz/Course project : 15 marks

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

Course Level Assessment Questions**CO1:To appreciate the mathematical modelling approach**

1	Discuss the classification of mathematical models
2	Explain how advection-diffusion equation is useful for modelling contaminant transport in ground water
3	How gaussian dispersion model is useful for air pollution modelling of point sources?

CO 2: To learn how to build a model to represent physical transport of pollutants in environment

1	Explain model building procedure
2	<p>What is the flow equation for the following situation?</p> 

3	Discuss how salinity intrusion is modeled
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CO3: To simulate pollution transport scenarios in water, air and noise environment

1	The SO ₂ concentration from 700 MW coal fired power plant has to be estimated. It burns 5% sulphur coal at the rate of 350KG / MW H. Stack height is 150m and plume rise is 50m. The wind speed at stack height is 6 m/s and neutral stability condition exists. Calculate the ground level concentration at 2 km downwind distance, given that $\sigma_y = 80\text{m}$ and $\sigma_z = 120\text{m}$.
2	The initial BOD of a river just below a sewage outfall is 25 mg/L. The oxygen deficit just upstream from the outfall is 2 mg/L. The deoxygenation rate coefficient k_d is 0.4/day, and the reaeration rate coefficient k_r is 0.7/day. The river is flowing at a speed of 30 km /day. (a) Find the critical distance downstream at which DO is a minimum (b) Find the minimum DO
3	Water levels in two wells far from shoreline are 50 cm and 1.0 m respectively. The wells are separated by a distance of 1 km. Hydraulic conductivity of the aquifer is 10m/d. Thickness of aquifer is 50m. Calculate the length of saltwater wedge and position of interface. Density of salt water can be taken as 1.025 g/cm ³

CO4: To interpret the modelling results for decision support

1	Explain how gaussian dispersion model help in predicting the impact of a proposed coal power plant in a locality
2	A chemical spill occurs above a sloping, shallow unconfined aquifer consisting of medium sand with $K=1$ m/d and a porosity of 30%. Several monitoring wells are drilled in order to determine the regional hydraulic gradient. The hydraulic head from a well drilled near the spill location yielded a value of 5m. At a distance of 200m down the slope another well yielded a hydraulic head of 1m. Do you need to worry about safe drinking water availability in the well 200 m down the slope?
3	The distance from the base of a pumping well to the freshwater-saltwater interface is 100 m, the pumping rate is 3000 m ³ /day, and the hydraulic conductivity is 10 m/d. What's the maximum permitted pumping rate for the well?

SYLLABUS**Module1**

Role of models in environmental pollution studies- objectives of modelling-modelling principles-types of models-classification of mathematical models-deterministic, stochastic, continuous, discrete, static, dynamic, linear and non-linear-model building framework-model calibration, validation, verification and sensitivity analysis-model scales, error and uncertainty -distributions in modelling data of environmental pollutant concentrations- log-normal, Weibull, and gamma

Module 2

Air pollution modelling: Transport and dispersion of air pollutants- estimating concentrations from point sources –Dispersion Modelling- Gaussian Plume Model – determination of dispersion parameters, atmospheric stability-box models- line source model-area source model-puff model

Module 3

Water quality modeling: historical development of water quality models; rivers and streams water quality modelling– low flow analysis – pollutant transport-advection, diffusion and dispersion— Modelling lake water quality-mass balance for well mixed lakes-models for dissolved oxygen; Streeter Phelps model- sediment transport modelling

Module4

Groundwater modelling: use of ground water models-ground water flow modeling-Darcy's law-ground water flow equations for homogenous, heterogenous, isotropic and anisotropic conditions-mass transport of solutes,advection diffusion equation,favorable conditions for contaminant transport-modelling parameters and boundary conditions, seawater intrusion – basic concepts and modeling-Ghyben–Herzberg formula-popular ground water models

Module5

Environmental noise - noise generation mechanisms- need for noise modelling- modelling inputs-sound propagation factors- Equivalent Continuous Sound Pressure Level (Leq)-noise mapping methodology-modelling traffic noise-CoRTN and RLS90 models

Text Books

1. Gilbert M Masters Wendell P Ela, Introduction to Environmental Engineering & Science, Pearson,2013
2. Steven C.Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies,Inc., New York, 1997.
3. Todd David Keith, Ground water Hydrology, Fourth edition, John Wiley and Sons, New York, 2004..
4. C.P Kumar, Ground water assessment and modelling, Createspace Independent Pub, 2015

References

1. Seinfeld and Pandis, Atmospheric chemistry and physics, Wiley 2016
2. Marcello Benedini, George Tsakiris, Water quality modelling for rivers and streams, Springer 2013
3. Mary Anderson William Woessner Randall Hunt, Applied ground water modelling, Academic Press, 2015
4. Enda Murphy Eoin King, Environmental Noise Pollution, Elsevier, 2014

Lecture Plan- Environmental Impact Assessment

Module	Topic	Course Outcomes addressed	No. of Lectures
1	Module 1: Total Lecture Hours -9		
1.1	Role of models in environmental pollution studies- objectives of modelling-modelling principles-	CO1	1
1.2	types of models-classification of mathematical models-deterministic, stochastic, continuous, discrete, static, dynamic, linear and non-linear-	CO1	2
1.3	model building framework-model calibration, validation, verification and sensitivity analysis-model scales, error and uncertainty -	CO2	3
1.4	distributions in modelling data of environmental pollutant concentrations- log-normal, Weibull, and gamma	CO1,CO2	3
2	Module II: Total Lecture Hours- 9		
2.1	Air pollution modelling: Transport and dispersion of air pollutants	CO2	1
2.2	estimating concentrations from point sources – dispersion modelling- Gaussian Plume Model – determination of dispersion parameters, atmospheric stability	CO2, CO3, CO4	4
2.3	box models- line source model-area source model-puff model	CO2, CO3, CO4	4
3	Module III: Total Lecture Hours-9		
3.1	Water quality modeling: historical development of water quality models	CO1,CO2	1

3.2	Rivers and streams water quality modelling– low flow analysis – pollutant transport-advection, diffusion and dispersion	CO2, CO3	2
3.3	Modelling lake water quality-mass balance for well mixed lakes	CO2, CO3	2
3.4	models for dissolved oxygen; Streeter Phelps model-	CO2, CO3,CO4	3
3.5	sediment transport modelling	CO2, CO3,CO4	1
4	Module IV: Total Lecture Hours- 9		
4.1	Groundwater modelling: use of ground water models-ground water flow modeling-Darcy's law-ground water flow equations for homogenous, heterogenous, isotropic and anisotropic conditions-	CO1,CO2	3
4.2	mass transport of solutes, advection dispersion equation, favorable conditions for contaminant transport-modelling parameters and boundary conditions	CO2,CO3,CO4	3
4.3	seawater intrusion – basic concepts and modeling-Ghyben–Herzberg formula, popular ground water models	CO2,CO3,CO4	3
5	Module V: Total Lecture Hours- 9		
5.1	Environmental noise - noise generation mechanisms-need for noise modellingnoise mapping methodology-	CO2	3
5.2	modelling inputs-sound propagation factors - Equivalent Continuous Sound Pressure Level (Leq)-	CO2	3
5.3	modelling traffic noise-CoRTN and RLS90 models	CO3	3

Model Question Paper

Reg No.: _____

Name: _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION****Course Code: CET398****Course Name: ENVIRONMENTAL POLLUTION MODELLING**

Max. Marks: 100

Duration: 3 Hours

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

1. Why do we need models in environmental studies?
2. A model can never represent the reality. Explain
3. What are the assumptions used in a box model?
4. Explain how atmospheric stability influence dispersion of air pollutants?
5. Explain Streeter-Phelps model
6. How modeling lake water quality is different from modeling river water quality?
7. Explain the role of Darcy's law in ground water modelling
8. Explain Ghyben-Herzberg relation
9. What are the parameters influencing propagation of environmental noise?
10. What you mean by Equivalent Continuous Sound Pressure Level ?

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

11. (a) Why do we need models? Explain with an example (5 Marks)
(b) Discuss various types of models used in environmental science (9 Marks)
- OR
12. (a) Reliability of a model does not necessarily increase with model complexity. Why? (5 Marks)
(b) Discuss the model building framework (9 Marks)
13. (a) An air sampling station is located at an azimuth of 203° from a cement plant at a distance of 1500 meters. The cement plant releases fine particulate matter at the rate of 94.5 g/s from a 30 meter high stack. What is the contribution from the cement plant to the ambient particulate

matter concentration at the sampling station when the wind is from 30° at 3 m/s. Given that $\sigma_y = 150\text{m}$ and $\sigma_z = 87\text{m}$ (9 Marks)

- (b) What is plume rise? How it influences air quality modelling? (5Marks)

OR

14. (a) How stability parameters used in Gaussian model are determined? (5 Marks)

- (b) Discuss in detail various air quality models and their use (9 Marks)

15. (a) Briefly discuss the historical development of water quality models (9 Marks)

- (b) What input data are needed for sediment transport modelling (4 Marks)

OR

16. (a) The initial BOD of a river just below a sewage outfall is 25 mg/L. The oxygen deficit just upstream from the outfall is 2 mg/L. The deoxygenation rate coefficient k_d is 0.4/day, and the reaeration rate coefficient k_r is 0.7/day. The river is flowing at a speed of 30 km /day.

- (i) Find the critical distance downstream at which DO is a minimum

- (ii) Find the minimum DO (9Marks)

- (b) Explain low flow analysis (5 Marks)

17. (a) An aquifer has a cross section with a horizontal width of 265m, and a vertical thickness below the water table of 42m. The water table is 36 m below the ground surface. Each day 3340 m³ of water is discharged through the cross section. The aquifer rock has an effective porosity of 27.1%. Find the Seepage velocity through the aquifer (5 Marks)

- (b) Discuss the basic mechanisms that drives the contaminant transport in ground water (9 marks)

OR

18. (a) What are the contaminant, soil and site properties and their combinations that are critical in the transport of contaminants to ground water (5 Marks)

- (b) The distance from the base of a pumping well to the freshwater-saltwater interface is 100 m, the pumping rate is 3000 m³/day, and the hydraulic conductivity is 10 m/d.

- (i) What will be the position of the interface?

- (ii) What's the maximum permitted pumping rate for the well? (9 Marks)

19. (a) Discuss the need for environmental noise modelling (5 Marks)

- (b) Explain noise mapping methodology (9 Marks)

OR

20. (a) Explain the noise generation mechanisms (5Marks)

- (b) Discuss how traffic noise can be modelled? (9 Marks)