CET292	COURSE NAME ADVANCED MECHANICS OF SOLIDS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Objective of this course is to expose the students to the advanced concepts of mechanics of materials and enhance their problem-solving skills. The course aims to understand the stresses and strains in 2D and 3D solid bodies. It introduces students to the elements of theories of elasticity, failure and failure criteria. Students will be able to understand concepts, principles and governing equations in dealing with elastic solids. After this course students will be in a position to find mechanical behaviour of elastic materials by determining the stress, strains produced by the application of load.

Prerequisite: Mechanics of Solids

Course Outcomes:

Course Outcome	Description of Course Outcome	Prescribed learning level
CO 1	To explain the material properties of solids and the state of stress and strain developed in solids due to applied loads.	Remembering, Understanding& Applying
CO 2	To illustrate the different failure theories and apply the apt failure criteria to find out the Factor of Safety against structural failure.	Applying& Analysing
CO 3	To predict the structuralresponse of standard cross sections of isotropic materials due to applied torsion.	Applying& 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	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-

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

Part A

Course Outcome 1 (CO1): (Two questions each from module 1 to module 3 to meet the course objective 1:*To understand the material properties of solids and the state of stress and strain developed in solids due to applied loads.*)

1. Explain stress invariants
2. Explain Stress space
3. Explain the transformation of strain
4. Explain transformation of stress
5. Listthe differential equations of equilibrium for three dimensional stress state.
6. State the assumptions in classical linear elasticity
7. Differentiate between principal stress and principal strain
8. List the six compatibility equations for a three dimensional system.
9. Distinguish between rectangular strain rosette and equiangular strain rosette.
10. Differentiate between stress tensor and strain tensor
12.Explain octahedral stresses & strain

Course Outcome 2 (CO2) (Two questions from module4 to meet the course objective 2: *To understand the different failure theories and apply the apt failure criteria to find the Factor of Safety.***)**

1. Discuss the failure criteria for ductile materials
2. Discuss the failure criteria for brittle materials
3. Explain Palm miner rule
4.Discuss the failure due to stress reversal
5.Explain SN Curve
6.Explain stress concentration factor

Course Outcome 3 (CO3) (Two questions from module 5 to meet the course objective 3: *To predict the structural response of standard cross sections of isotropic materials due to applied torsion.***)**

1. Discuss the use of St Venants semi inverse method
2. Explain Prandtl's membrane analogy

Part B

All the questions under this section shall assess the learning levels corresponding to the course outcomes listed below.

CO 1	To understand the material properties of solids and the state of stress and strain developed in solids due to applied loads.
CO 2	To learn the different failure theories and apply the apt failure criteria to find the Factor of Safety against structural failure.
CO 3	To predict the structural response of standard cross sections of isotropic materials due to applied torsion.

1. The state of strain at a point in an isotropic material is given by strain tensor.

$$\begin{bmatrix} 0.002 & 0 & -0.002 \\ 0 & -0.004 & 0.0006 \\ -0.002 & 0.0006 & 0 \end{bmatrix}$$

Determine stress tensor at this point. Take E = 200 GPa. Poisson's ratio = 0.3.

Course outcome identifier	**Description of course outcome**	**Learning level assessed**	**Marks allocated**
CO 1	To explain the material properties of solids and the state of stress and strain developed in solids due to applied loads.	Remembering – (Relation between Lame's Constants and E & poisons ratio) (D matrix for Isotropic Material)	4
		Understanding- (Constitutive Stress – strain Relationship)	2
		Analysing-(Computation of stress from strain with application of Constitutive stress strain relationship)	6
		Applying- (Formation of Stress tensor from stress components)	2
Total			14

2. A low carbon steel shaft is designed to have a diameter of 25 mm. It is to be subjected to an axial load P= 20 kN , a moment M = 130 N m, and a torque T = 220 Nm. If the yield point for the steel is 260 MPa, determine the factor of safety used in the design of the shaft based on the a) Tresca criterion of failure b)Von mises criterion of failure assuming that failure occurs at initiation of yielding.

Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 1	To explain the material properties of solids and the state of stress and strain developed in solids due to applied loads.	Analysing – (Computation of state of stress from loading situation)	6
CO 2	To illustrate the different failure theories and apply the apt failure criteria to find the Factor of Safety against structural failure.	Remembering – (Formulae for the Tresca & Von mises Criteria)	4
		Applying – Computation of Factor of Safety	4
Total			14

3. A square shaft has 42.0 mm sides and has the same cross sectional area as shafts having circular and equilateral triangular cross sections. If each shaft is subjected to a torque of 1kNm, Determine the maximum shearing stress for each of the three shafts.

Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 3	To predict the structural response of standard cross sections of isotropic materials due to applied torsion.	Understanding – (Knowledge regarding Saint Venant's Semi Inverse Method)	4
		Applying-(Use of Stress Function)	2
		Remembering- (Relation between maximum shear stress with applied Torsion and the geometric parameters	4
		Applying- (Use of appropriate Equation)	4
Total			14

Model Question Paper
CET292 - Advanced Mechanics of Solids

Qn No	Questions	Marks	Course Outcome (CO) Assessed
	Part A (Answer all questions; each question carry 3 marks)		
1	Explain transformation of stress	3	1
2	Differentiate between spherical and Deviatorial stress tensor	3	1
3	Explain strain invariants	3	1
4	Distinguish between rectangular strain rosette and equiangular strain rosette	3	1
5	List the six compatibility equations for a three dimensional system	3	1
6	List out the differential equations of equilibrium for three dimensional stress state.	3	1
7	Discuss the failure criteria for ductile materials	3	2
8	Explain stress concentration factor	3	2
9	Discuss the use of St Venants semi inverse method	3	3
10	Explain Prandtl's membrane analogy	3	3
	Part B (Answer one full question from each module, each question carry 14 marks)		
	Module I		
11(a)	Derive the expression for the stress on arbitrarily plane whose unit normal vector is defined by $li+mj+nk$ for a rectangular coordinate system with x,y and z as reference axes.	6	1
11 (b)	Find the expression for the Normal stress and Shearing stress on a new coordinate system with X,Y and Z as the reference axes.X axis is defined by $l_1i+m_1j+n_1k$, Y axis is defined by $l_2i+m_2j+n_2k$ andZ axis is defined by $l_3i+m_3j+n_3k$	8	1
	OR		
12 (a)	A rectangular bar of metal of cross section 20 mm x 35 mm is subjected to an axial tensile force of 180 kN. Calculate the normal, shear and resultant stresses on a plane whose normal has the following direction cosines $l=m=n=1/\sqrt{3}$	7	1
12(b)	The state of stress at a point is given by the following array of terms	7	1

	$\begin{bmatrix} 3 & 6 & 3 \\ 6 & 6 & 2 \\ 3 & 2 & 9 \end{bmatrix}$ MPaDetermine the principal stresses and the principal directions. Find out the stress invariants in principal plane and show that it remains unchanged.		
	Module II		
13 (a)	By means of strain rosette, the following strains were recorded during the test on a structural member. ε_0 = 950 micrometres/m,ε_{45} = -110micrometres/m, ε_{90} = 110micrometres/m. Determine the magnitude and directions of principal strains.	7	1
13(b)	If the displacement field in a body is specified as u = $(x^2+4)\ 10^{-3}$,v= $5y^2z * 10^{-3}$ and w = $(x + 2z)\ 10^{-3}$.Determine the strain tensor at a point whose coordinates are (3,2,3)	7	1
	OR		
14	The strain components at a point with respect to xyz co-ordinate system are $\varepsilon_x = 0.15$, $\varepsilon_y = 0.16$, $\varepsilon_z = 0.35$, $\gamma_{xy} = \gamma_{yz} = \gamma_{xz} = 0.170$. If the coordinateaxes are rotated about the z-axis through 45° in the anticlockwise direction, determine the new strain components.	14	1
	Module III		
15	The state of strain at a point is given by strain tensor. $\begin{bmatrix} 0.002 & 0 & -0.002 \\ 0 & -0.004 & 0.0006 \\ -0.002 & 0.0006 & 0 \end{bmatrix}$ Determine stress tensor at this point. Take E = 200 GPa. Poisson's ratio = 0.3.	14	1
	OR		
16(a)	Under what conditions are the following expressions for the components of strain at a point compatible? $\varepsilon_x = 2axy^2 + by^2 + 2cxy$, $\varepsilon_y = ax^2 + bx$, $\gamma_{xy} = \alpha x^2 + \beta xy + ax^2 + \eta y$	7	1
16(b)	The stress components at a point in a body are given by $\sigma_x = 5xy^2z + 2x$, $\sigma_y = 3xyz + 3y$, $\sigma_z = x^2y + y^2z$, $\tau_{xy}=0$, $\tau_{yz}= \tau_{xz}= 2xy^2z+2xy$ Determine whether these components of stress satisfy the equilibrium equations or not at the point (1,-1,2). If not then determine the suitable body force required at this point so that these stress components are under equilibrium.	7	1

	Module IV		
17	Represent all the yield criteria for failure graphically in the 2D stress space with rectangular axes σ_1 and σ_2 for the material steel. Assume the yield point of steel as 350 MPa and poisson ratio as 0.25. Mention the equation also in the graph.	14	2
	OR		
18	A closed end thin-walled cylindrical of a metal with yield point = 700 MPa has an inside diameter of 20mm. The cylinder is subjected to an internal pressure of 22 MPa and an axial load of 50 kN. Determine the torque that can be applied to the cylinder if the factor of safety for design is 1.80. Check whether the material is safe under Von mises criteria.	14	2
	Module V		
19	A hollow thin-wall brass tube has an equilateral triangular cross section. The mean length of each side of the triangle is 40.0mm. The wall thickness is 4.00mm. Determine the torque and unit angle of twist for an average shearing stress of 20.0 MPa. (G = 31.1 GPa)	14	3
	OR		
20	A torsion member has an elliptical cross section with major and minor dimensions of 100 mm and 70 mm, respectively. The yield stress of the material is 350 MPa. Determine the maximum torque that can be applied to the torsion member based on a factor of safety 1.8 using maximum shearing stress criterion of failure.	14	3

Syllabus

Module 1 Stress in 3-D

Definition of stress at a point, Stress Notation, Stress Tensor, Normal stress and Shearing Stress on an oblique plane, Transformation of stress, Principal Stress, Stress Invariants, Octahedral Stress, Mean and Deviator Stress, Plane stress, Mohr's Circle in Two Dimensions, Differential Equations of motion of a deformable body.

Module 2 Strain in 3-D

Types of Strain, Deformation of a deformable body, Strain Tensor, Strain Transformation, Spherical and Deviatorial Strain Tensor, Principal Strains, Strain Invariants, Octahedral Strains, Mohr Circle for strain, Equations of Compatibility for Strain, Strain Rosettes

Module 3 Elements of Theory of Elasticity

Strain Energy Density, Complementary Internal Energy Density, Elasticity and Strain Energy Density,Elasticity and Complementary Internal Energy Density, Generalized Hooke's Law, Anisotropic Elasticity, Isotropic Elasticity,Displacements-strains and compatibility-equilibrium equations and boundary conditions

Module 4 Failure and Failure criteria

Modes of failure, yield failure criteria, Maximum Principal Stress Criteria, Maximum Shear stress criteria, Maximum Strain Criteria, Maximum Strain Energy Density Criteria, Von Mises Criteria, fatigue, Stress Concentration Factor, Palm Miner Rule, SN Curve

Module 5 Torsion

Torsion of a cylindrical bar of circular cross section- St.Venant's semi inverse method-stress function approach-elliptical, equilateral triangle & narrow rectangular cross sections - Prandtl's membrane analogy-Hollow thin wall torsion members

Text Books

1. A.P. Boresi and O.M.Sidebottom, Advanced Mechanics of Materials, 4th edition, John Wiley & Sons,1985

2.R.D. Cook and W.C. Young, Advanced Mechanics of Materials, 2nd edition, Prentice Hall Intl,Inc.1999

3. Srinath L.S, Advanced Mechanics of Solids, Tata McGraw Hill, 3e, 2009

Reference Books

1. S P Timoschenko, Strength of Materials Vol II ,CBS Publishers, 2002

2. Shames, E.H., Mechanics of Deformable solids, Prentice Hall Inc., 1964

3. Timoshenko S.P and Goodier J.N, Theory of elasticity, McGraw Hill, 3e, 1970

Lecture Plan – Advanced Mechanics of Solids

Module	*Topic*	*Course outcomes addressed*	*No. of Lectures*
1	**Module I : Total lecture hours : 9**		
1.1	Definition of stress at a point, Stress Notation, Stress Tensor, Mean and Deviator Stress	CO1	Lecture 1
1.2	Definition of Plane, Normal Stress on an oblique plane	CO1	Lecture 2
1.3	Shearing Stress on an oblique plane	CO1	Lecture 3
1.4	Transformation of stress, Principal Stress,	CO1	Lecture 4
1.5	Stress Invariants &Octahedral Stress.	CO1	Lecture 5
1.6	Plane stress &Mohr's Circle in Two Dimensions	CO1	Lecture 6
1.7	Differential Equations of motion of a deformable body	CO1	Lecture 7
2	**Module II : Total lecture hours : 9**		
2.1	Types of Strain &Deformation of a deformable body	CO2	Lecture 1
2.2	Strain Tensor & Strain Transformation,	CO2	Lecture 2
2.3	Spherical and Deviatorial Strain Tensor	CO2	Lecture 3
2.4	Principal Strains & Strain Invariants	CO2	Lecture 4
2.5	Octahedral Strains & Mohr Circle for strain	CO2	Lecture 5
2.6	Equations of Compatibility for Strain	CO2	Lecture 6
2.7	Strain Rosettes	CO2	Lecture 7
3	**Module III : Total lecture hours : 9**		
3.1	Strain Energy Density & Complementary Internal Energy Density	CO3	Lecture 1
3.2	Elasticity and Strain Energy Density	CO3	Lecture 2
3.3	Elasticity and Complementary Internal Energy Density	CO3	Lecture 3
3.4	Generalized Hooke's Law	CO3	Lecture 4
3.5	Anisotropic Elasticity & Isotropic Elasticity	CO3	Lecture 5
3.6	Displacements-strains and compatibility	CO3	Lecture 6
3.7	Equilibrium equations and boundary conditions	CO3	Lecture 7

4	**Module IV : Total lecture hours : 9**		
4.1	Modes of failure, yield failure criteria,	CO4	Lecture 1
4.2	Maximum Principal Stress Criteria &Maximum Shear stress criteria	CO4	Lecture 2
4.3	Maximum Strain Criteria	CO4	Lecture 3
4.4	Maximum Strain Energy Density Criteria	CO4	Lecture 4
4.5	Von Mises Criteria	CO4	Lecture 5
4.6	fatigue, Stress Concentration Factor	CO4	Lecture 6
4.7	Palm Miner Rule & SN Curve	CO4	Lecture 7
5	**Module V : Total lecture hours : 9**		
5.1	Torsion of a cylindrical bar of circular cross section	CO3	Lecture 1
5.2	St.Venant's semi inverse method	CO3	Lecture 2
5.3	Stress function approach- elliptical	CO3	Lecture 3
5.4	Torsion- Equilateral triangle cross sections	CO3	Lecture 4
5.5	Torsion- narrow rectangular cross sections	CO3	Lecture 5
5.6	Prandtl's membrane analogy	CO3	Lecture 6
5.7	Hollow thin wall torsion members	CO3	Lecture 7

CET 294	PAVEMENT CONSTRUCTION AND MANAGEMENT	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		VAC	4	0	0	4	2019

Preamble

Objective of the course is to introduce the principles and practice of Highway construction and infrastructure asset management

Prerequisite: NIL

Course Outcomes:

	Description
CO No.	At the end of the course, students will be able to:
CO 1	To understand the characterization of materials used for pavement construction
CO 2	To carry out mix design of various bituminous mixes
CO 3	To study construction practices of flexible pavement and equipment used
CO 4	To understand the construction practices and reinforcement design of rigid pavement
CO 5	To study the fundamentals of pavement evaluation and pavement management system

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (marks)
	Test 1 Marks	Test 2 Marks	
Remember	**10**	**10**	**30**
Understand	**10**	**10**	**30**
Apply	**5**	**5**	**20**
Analyse	**5**	**5**	**20**
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:

The question consists of two parts- Part A and Part B. Part A consists of 10 questions with 3 marks for each (two questions from each module). Part B consists of two questions from each module, out of which one has to be answered. Each question carries 14 marks and can have maximum 2 subdivisions.

Sample Course Level Assessment Questions:

Course Outcome 1 (CO1): Explain the desirable properties of aggregates to be used in different types of pavement construction?

Course Outcome 2 (CO2): A bitumen mixture contains 60% coarse aggregate; 35% fine aggregate; 5% asphalt (by weight). Determine unit weight of mixtureafter compaction with 7% air voids? G_{CA}=2.72, G_{FA}=2.66, G_A=1.0

Course Outcome 3 (CO3): Explain the method of preparation of mix and construction steps for laying bituminous macadam base course?

Course Outcome 4 (CO4): With neat sketch explain the joints in cement concrete pavements?

Course Outcome 5 (CO5): Compare project level and network level pavement management systems.

Syllabus

Module 1

Pavement: functions and characteristics- Types of pavement: flexible pavement, rigid pavement, comparison- Different layers of flexible and rigid pavement
Pavement materials: characterization of sub grade soil, soil classification system, properties of road aggregate, principles and methods of gradation of soil aggregate mixes, characteristics and uses of bitumen, emulsion cutback and modified bitumen.

Module 2

Bituminous pavement types: penetration layer system and premixed aggregate- specification of materials,
Mix design:physical and volumetric properties of bituminous mix, Marshall method of mix design, Super pave mix design

Module 3

Construction of flexible pavement: functions of various layers, preparation and construction of sub grade, granular sub base (GSB), WBM, WMM, Bituminous macadam, Different types of wearing courses. specifications/ guild lines, equipment used for the construction of different layers in flexible pavement, quality control for flexible pavement construction

Module 4

Construction of cement concrete pavement: material characterization, preparation of subgrade and base, Types of joints in Rigid pavements its functions and design, presetting reinforcement in joints and PCC slab construction

Module 5

Introduction to pavement management system(PMS): concept, definition, objectives, components, general structure- data collection pavement evaluation, functional and structural evaluation, pavement deterioration models, pavement management levels: network, programme and project level- types of pavement management system, Types of Maintenance and rehabilitation activities, life cycle cost analysis of strategies, popular software

TEXT BOOKS

1. Khanna, S.K, Justo E.G, .A Veeraragavan, Highway Engineering 10th edition, Khanna Publishers.2018

2. Kadiyali, L. R., Principles of Highway Engineering, Khanna Publishers, 2001

3. Rajib B. Mallick and TaharEl-Korchi, Pavement Engineering CRC press, 2009

4. Rao G. V, Principles of Transportation and Highway Engineering, Tata McGrawHill, 1996

5. Prithvi Singh Khandhal, Bituminous Road Construction in India, PHI Learning, 2019

REFERENCES

1. Manual for construction and supervision of Bituminous works, MoRTH 2001

2. Shahin M.Y, Pavement Management for Airports, Roads and Parking lots, Chapman & Hall, 2005

3. IRC: 37-2018, Guidelines for the Design of Flexible Pavements, IRC 2018, New Delhi

4. MoRTH, IRC code for pavement evaluation, data collection

Course Content and lecture Schedule:

Sl No.	Topic	Course Outcome	No of Hours
1	**Module 1**		Total:10
1.1	Functions and characteristics of pavements, Types of pavement and comparison (flexible pavement, rigid pavement)	CO1	1
1.2	Different layers and properties of flexible and rigid pavement	CO1	1
1.3	characterization of sub grade soil and soil classification system	CO1	2
1.4	Properties of road aggregate, principles and methods of gradation of soil aggregate mixes	CO1	3
1.5	Characteristics and uses of bitumen, emulsion cutback and modified bitumen	CO1	3
2	**Module 2**		Total:8
2.1	Penetration layer system and premixed aggregate system	CO2	2
2.2	Physical and volumetric properties of bituminous mix, Marshall method of mix design, Superpave Mix design	CO2	6
3	**Module 3**		Total:8
3.1	Functions of various layers of flexible pavement, preparation and construction of sub grade, granular sub base (GSB),WBM, WMM , Bituminous macadam, Different types of wearing courses specifications/ guidelines	CO3	4
3.2	Equipment used for the construction of different layers in flexible pavement, quality control for flexible pavement construction	CO3	4
	Module 4		Total:6
4.1	Construction of cement concrete pavement :material characterization, preparation of subgrade and base	CO4	3
4.2	Types of joints in Rigid pavements its functions and design, presetting reinforcement in joints and PCC slab construction	CO4	3
	Module 5		Total:13
5.1	Introduction to pavement management system(PMS): concept, definition, objectives, components, general structure-data collection	CO5	3
5.2	Pavement evaluation, functional and structural evaluation, pavement deterioration models,	CO5	3
5.3	Pavement management levels: network, program and project level	CO5	2
5.4	Types of pavement management system, Types of Maintenance and rehabilitation activities	CO5	2
5.5	life cycle cost analysis of strategies, popular software	CO5	3

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

Course Code:**CET 294**

Course Name: **PAVEMENT CONSTRUCTION AND MANAGEMENT**
Model Question Paper

Marks:100 Duration: 3 hrs

PART A
(Answer all Questions: Each question carries 3 marks)

1. What are the functions of pavement?
2. Define emulsified and cutback bitumen
3. What are the types of bitumen mixes for pavement?
4. Define VMA and VFB
5. Draw a typical cross section of a highway in cutting and show the various flexible pavement layers
6. What are the common types of equipment for compaction of soil for embankment and subgrade?
7. Draw a neat diagram showing various component layers of a CC pavement structure.
8. What are objects of providing dowel bars in CCpavement?
9. Differentiate between functional and structural evaluation of pavement.
10. What are the objectives of Pavement Management System?

(3 x 10 = 30)

PART B
(Answer one full question from each module)

11. a) Differentiate between flexible and rigid pavement
(7)

b) Explain CBR and the test procedure in the laboratory. How are the results of the test obtained and interpreted?
(7)

OR

12. a) What are the desirable properties of road aggregates? Explain aggregate impact test and shape test.
(10)

b) Explain grading of bitumen
(4)

13. a) Differentiate between dense graded and gap graded mixtures, giving one example for each
(6)

b) In a Marshall test, bituminous concrete cylinder is made whose weight is 1250 gms with the volume of 820 cc. The weights and specific gravities of various ingredients are given in the table. Determine VMA and VFB.
(8)

Type	A1	A2	A3	Flyash	Bitumen
Wt (g)	868	322	430	350	180
G	2.78	2.63	2.32	2.36	1.05

OR

14. a) Explain the Marshall method of bituminous mix design
(10)

b) In a bituminous concrete mix the theoretical specific gravity is 2.434, bulk specific gravity is 2.323, specific gravity of bitumen used is 1.05 with 4.35% weight of bitumen in the mix. Determine VMA, VFB.
(4)

15. a) Explain the construction procedure for base and sub-base courses in flexible pavement construction
(7)

b) List various excavating machinery used during highway construction. Mention the uses and limitations of each
(7)

OR

16. a) Write notes on the following types of bituminous pavement layers (i) stone matrix asphalt (ii) slurry seal (iii) micro-surfacing
(7)

b) What are the quality control tests during the construction of bituminous concrete layer? Mention the objectives of each
(7)

17. a) Write anote on importance and construction of (i) drainage layer for CC pavement (ii) dry lean concrete sub-base course (iii) separation membrane (10)

b) A rigid pavement is constructed at 28^{o}C, peak summer temperature is 45^{o}C, peak winter temperature is 10^{o}C, the gap at expansion joint is 25mm, α_c=10x10-6 /^{o}C. Calculate the spacing of expansion joint?
(4)

OR

18. a) What are the different materials required for the construction of a CC pavement? Mention how a concrete mix is designed for obtaining PQC.
(7)

b) Classify different types of joints in CC pavements and mention the objects of each.
(7)

19. a) Differentiate between destructive and non-destructive structural evaluation of pavement. (7)

b) Compare project level and network level pavement management system
(7)

OR

20. a) Discuss the structure (component) of a Pavement Management System
(8)

b) Explain Life Cycle Cost Analysis
(6)

CET 296	GEOGRAPHICAL INFORMATION SYSTEMS	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 the fundamental concepts and components of Geographical Information System (GIS). After successful completion this course, students will be able to identify the requirements for the development of GIS module for various applications.

Prerequisite: Nil

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

Course outcome identifier	Description of course outcome	Prescribed learning level
CO 1	To define terms, basic concepts and operations in GIS	Remembering
CO2	To identify various data types and their characteristics.	Understanding
CO 3	To illustrate various approaches of spatial data analysis and their significance in decision making.	Applying
CO 4	To demonstrate the application of GIS and allied technologies across diverse fields.	Applying

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	1	-	-	-	-	-	-	-	-	-	-	-
CO 2	1	2	-	-	-	-	-	-	-	-	-	-
CO 3	2	3	2	-	2	-	-	-	-	-	-	-
CO 4	2	3	2	-	2	-	-	-	-	-	-	-
CO5												

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	7.5	7.5	30
Understand	7.5	7.5	30
Apply	10	10	40
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 contains 10 questions with 2 questions from each module and each question shall carry 3 marks. 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

Syllabus

Module 1

Basic concepts of GIS , History of GIS, Components of GIS-Geospatial Data, Attribute data, GIS operations, Application of GIS, Popular GIS Softwares.

Geographic Co-ordinate system, Map Projections, Commonly used Map Projections, Projected co-ordinate system, Georeferencing, Geometric Transformations.

Tutorial- Introducing any GIS software and its tools.

Module 2

Data structure -Vector Data model, Raster Data model, Types of Raster data, Data inputs to GIS platform, Metadata, Vector to Raster conversion, Digitization.

Geodatabase management, Attribute data management. Cartography and map making elements.

Tutorial exercises: Georeferencing, raster to vector conversion, assigning attribute data

Module 3

GIS Data Processing –Vector data Analysis- Buffering, Overlay-Point-in-Polygon, Line-in-polygon, Polygon-in-polygon, Distance measurement, Pattern analysis, Map manipulation, Network Analysis

Raster Data Analysis- Local operations, Neighbourhood operation, Zonal Operation, other Raster data operations.

Tutorial exercises: Digitization using available data source and creating a Map Using different map elements.

Module 4

Advanced Applications: Introduction to terrain mapping, DEM and TIN, terrain mapping techniques, Slope and aspect, WebGIS.

Data quality analysis – Sources of Error – Components of Data Quality

Tutorial exercises: working with a surface / terrain models

Module 5

Remote sensing: Definition, Basic Principles, Application of remote sensing in GIS.

Global Positioning System (GPS) - GPS Basic concepts, GPS segments-satellites & receivers, GPS applications. Application of *GPS data in GIS environment.*

Tutorial exercises: Create a small GIS module using GPS or RS data.

Text Books:

1. Chang,K , "Introduction to Geographic Information Systems", Tata McGraw-Hill Publishing Co. Ltd, 2008

2. George Joseph, "Fundamentals of Remote Sensing", University Press, 2003

3. Robert Laurini and Derek Thompson, "Fundamentals of Spatial Information Systems", Academic Press, 1996.

References:

1. BurroughP, Principles of Geographical Information systems, Oxford University Press, 1998
2. Iliffe, C.J., Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, 2006
3. Kang-tsung Chang, „Introduction to GIS" , Tata McGraw-Hill Publishing Co. Ltd, 8e, 2016
4. Lillesand M and Kiefer W, "Remote Sensing and Image Interpretation". John Wiley and Sons,Inc., 2000

5. Iliffe, C.J., Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, 2006

Course Contents and Lecture Schedule:

No.	Topic	Course Outcome	No. of Hrs
1	**Module 1**		Total: 9
1.1	**Basic concepts of GIS** , History of GIS, Components of GIS- Geospatial Data, Attribute data, GIS operations, Application of GIS , Popular GIS Softwares.	CO1, CO2	3
1.2	**Co-ordinate system:**Geographic Co-ordinate system, Map Projections, Commonly used Map Projections, Projected co-ordinate system, Georeferencing, Geometric Transformations.	CO1, CO2	4
1.3	Tutorial- Introducing a GIS software and its tools.	CO1, CO2	2
2	**Module 2**		Total: 9
2.1	**Data structure**-Vector Data model, Raster Data model, Types of Raster data, Data inputs to GIS platform, Metadata, Vector to Raster conversion, Digitization.	CO1. CO2 CO3	4
2.2	**Database management and map making:**Geodatabase management, Attribute data management. Cartography and map making elements.	CO1, CO2 CO3	3
2.3	*Tutorial exercises: Digitization using available data source and creating a Map Using different map elements.*	CO2, CO3	2
3	**Module 3**		Total: 9
3.1	**GIS Data Processing** – Vector data Analysis- Buffering, Overlay- Point-in-Polygon, Line-in-polygon, Polygon-in-polygon, Distance measurement, Pattern analysis, Map manipulation, Network Analysis	CO1, CO2 CO3,CO4	4
3.2	**Raster Data Analysis-** Local operations, Neighbourhood operation, Zonal Operation, other Raster data operations.	CO1,CO2 CO3,CO4	3
3.3	*Tutorial exercises: Digitization using available data source and creating a Map Using different map elements.*	CO3,CO4	2
4	**Module 4**		Total: 9
4.1	**Advanced Applications:** Introduction to terrain mapping, DEM and TIN, terrain mapping techniques, Slope and aspect, WebGIS.	CO1,CO2 CO3,CO4	4
4.2	**Data quality analysis –** Sources of Error – Components of Data Quality	CO1,CO2 CO3,CO4	3
4.3	*Tutorial exercises: working with a surface / terrain models*		2
5	**Module 5**		Total: 9
5.1	**Remote sensing:** Definition, Basic Principles, Application of remote sensing in GIS.	CO1,CO2 CO3,CO4	3
5.2	**Global Positioning System (GPS)** - GPS Basic concepts, GPS segments-satellites & receivers, GPS applications. Application of GPS data in GIS environment.	CO1,CO2 CO3,CO4	4
5.3	*Tutorial exercises: Create a small GIS module using GPS or RS data.*	CO3, CO4	2

Sample Course Level Assessment Questions

CO 1	To define terms, basic concepts and operations in GIS
CO2	To identify various data types and their characteristics.
CO 3	To illustrate various approaches of spatial data analysis and their significance in decision making.
CO 4	To demonstrate the application of GIS and allied technologies across diverse fields.

CO1

1. Prepare a short account on Geodetic datum, Ellipsoid earth model and Georeferencing
2. State any two functions of a GIS module
3. Write a short note on Digital Elevation Model.

CO2

1. Compare raster data sets and vector data sets. Highlight their significance in GIS environment
2. Briefly explain raster data form in GIS.
3. Explain any two approaches for spatial data acquisition for infrastructure development process.

CO3

1. Prepare short description on (i) Positional accuracy (ii) Attribute accuracy
2. Explain any two types of errors associated with spatial data analysis.
3. Explain different type of image resolutions and establish their importance in the GIS analysis.

CO4

1. Briefly illustrate the utility of GIS module in tracking and navigation.
2. Explain how GPS is used in the map preparation and locating ground features.
3. Highlight the advantages offered by remote sensing operation in the developmental decision making.

Model Question Paper

QP CODE:

Reg No.:_____ Name:_____

ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CET 296

Course Name : GEOGRAPHICAL INFORMATION SYSTEMS

Max. Marks: 100 Duration: 3 hours

PART A

(Answer all questions)

(10 ×3 = 30)

1. Illustrate any two spatial data collection methods adopted for preparation of GIS.
2. What are the different components in GIS?
3. Define (i) Vector data (ii) Raster data
4. Establish the role of shapefiles in GIS.
5. Distinguish between pattern analysis and network analysis.
6. Demonstrate the significance of buffering in GIS
7. State any two sources of data error.
8. Define the terms : Slope and Aspect
9. List any two applications of GIS in combination with GPS.
10. Illustrate the role of atomic clock in GPS.

PART B

11 (i) Explain different techniques of remote sensing used for data collection

(ii) What is the role of georeferencing in GIS operation

(7 + 7)

or

12 (i) illustrate any three applications of GIS

(ii) Compare cylindrical projections and conical projections

(6+ 8)

13 (i) What are the different models adopted to represent vector data?

(iii) Highlight the role of digitisation in map preparation

(7 + 7)

or

14 (i) List the steps involved in the preparation of a digital map.

(ii) Compare continuous raster and discrete raster

(6+ 8)

15. (i) Prepare a short account on (a) Pattern analysis (b) Network analysis.

(ii) Illustrate any two raster data operations

(7 + 7)

or

16. (i) Explain any three factors that influences the choice of weights in the analysis of networks.

(ii) What are the different zonal operations suggested in the neighborhood analysis of raster data ?

(6 + 8)

17. (i) Explain the importance of using DEM for various engineering analysis.

(ii) Prepare different sources of error in a GIS operation.

(7 + 7)

or

18 (i) State any two approaches to reduce the error in GPS data transfer

(ii)Prepare a brief description of GIS data standard.

(7+7)

19. (i) Differentiate between ground based remote sensing and satellite based remote sensing ?

(ii) Justify - integration of GIS and GPS technologies could solve different problems faced in logistic operations.

(6 + 8)

or

20. (i) Explain different components of a GPS segment.

(ii) Illustrate the utility of remote sensing data in GIS module using any two cases.

(7+ 7)

CET393	STRUCTURAL DYNAMICS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: Structural Dynamics deals with the study of the behavior of structures under dynamic loads. The course provides the basic concepts of structural dynamics and the theoretical background to perform dynamic analysis of structures. The course focuses on analysis of single and multi-degree of freedom systems. An introduction to continuous system is also included. The course also provides an introduction to earthquake analysis of structures.

Prerequisite:- Nil

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	Explain the basic terms and principles associated with structural dynamics.	Remembering/ Understanding
CO2	Model single and multi-degree freedom systems for dynamic analysis and develop equations of motion.	Applying
CO3	Estimate parameters of dynamic systems	Applying
CO4	Perform dynamic analysis of single and multi degree freedom systems.	Applying
CO5	Analyse and design vibration isolation systems.	Applying
CO6	Develop equations of motion for dynamic analysis of beams and perform free vibration analysis of simply supported beam.	Applying

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember/ Understand	15	15	30
Apply	35	35	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

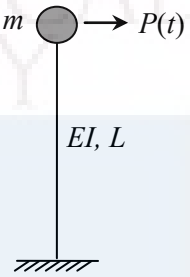
CO1: Explain the basic terms and principles associated with structural dynamics.

1. State and explain D'Alembert's principle.
2. How do you model a system for dynamic analysis?
3. What are the components of a dynamic system? Explain.
4. What is natural frequency of a dynamic system?
5. Explain critically damped, over damped and under damped systems.
6. What is damping ratio? What is its significance?
7. Write short notes on 'transient state' and 'steady state' responses.
8. Explain 'dynamic magnification factor'.
9. What is 'impulse response function'? What is its significance?

10. Write short notes on ‘Duhamel integral’.
11. Define ‘Transmissibility’ and explain its use in the design of vibration isolation systems.
12. State and derive the orthogonality properties of mode shape vectors.
14. Explain proportional and non-proportional damping models.
14. Write short notes on ‘earthquake response spectrum’.

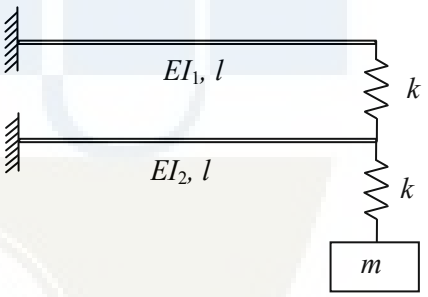
CO2: Model single and multi degree freedom systems for dynamic analysis and develop equations of motion.

1. Obtain the spring mass model of the system shown and develop the equation of motion.
Mass of column may be neglected.

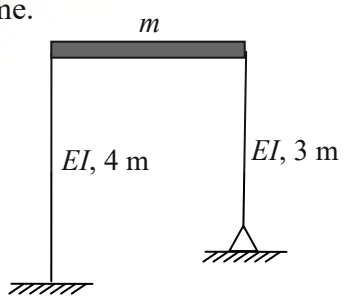


2. A simply supported beam of span L carried a central concentrated mass M. Model the system for analysis of tranverse vibrations. Neglect mass of the beam and damping. The flexural rigidity of the beam is EI.

3. Develop spring mass model of the System shown.
Take $m = 30$ kg, $EI_1 = 4000$ Nm^2, $EI_2 = 3200$ Nm^2, $l = 1$ m and $k = 2500$ N/m.

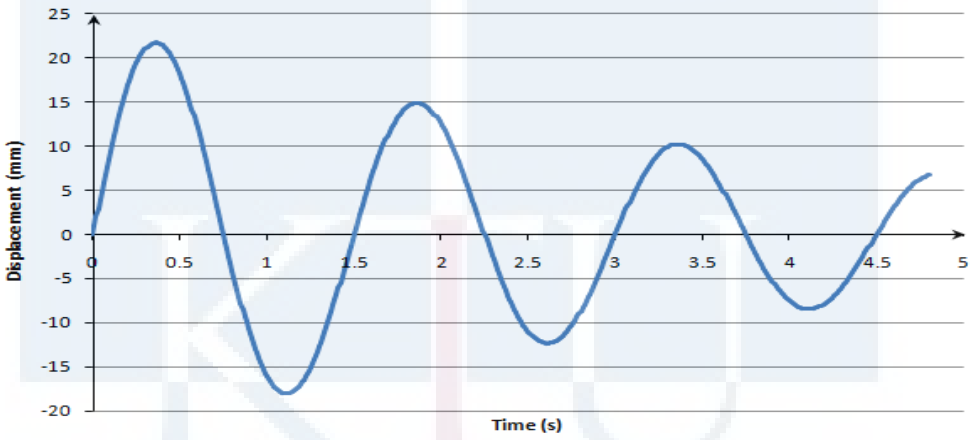


4. A rigid bar of length L is hinged at one end and carries a mass m at the other end. The bar is kept in a horizontal position with the support of a spring of stiffness k placed at a distance a from the hinged end. Formulate the equation of motion. Neglect mass of the bar and damping.
5. Develop spring- mass model of the following frame.



CO3: Estimate parameters of dynamic systems

1. Estimate the stiffness of the system shown in sample Qn. 3 of CO1.
2. A free vibration test is conducted on an empty elevated water tank. A cable attached to the tank applies a horizontal force of 100 kN and pulls the tank horizontally by 40 mm. The cable is suddenly cut and the resulting free vibration is recorded. At the end of four complete cycles, the time is 2 s and the amplitude is 25 mm. From these data compute the following: (a) damped natural frequency, (b) damping ratio, (c) effective stiffness and (d) effective mass
3. Figure shows the time history of displacement response of a SDOF system, of mass 50 kg, undergoing free vibration. Estimate the damped natural frequency, damping ratio and undamped natural frequency of the system. Also determine the stiffness and damping coefficient of the system.



4. A portable harmonic loading machine is used to conduct a test on a single storied building. Harmonic loads of magnitude 2000 N are applied at the floor level at two different frequencies. The data is given below.

Frequncy of load (rad/s)	Response Amplitude (cm)	Phase angle (degree)
8	1.50	7
10	2.25	13

Estimate the mass, stiffness and damping of the system assuming it as a single degree of freedom system.

CO4: Perform dynamic analysis of single and multi degree freedom systems.

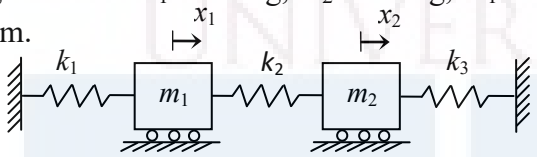
1. Calculate the natural frequency and natural period of transverse vibrations of a cantilever beam 50 mm diameter circular section carrying a load of 600 N at the free end. Span of the cantilever is 1.0 m. Modulus of elasticity of the material of the beam is 205 GPa. If a spring of stiffness 50 kN/m is introduced between the load

and the beam, calculate the change in the natural frequency and natural period.

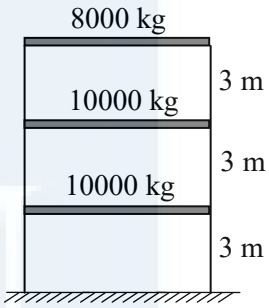
2. A SDOF system with mass 20 kg and stiffness 1800 N/m is given an initial displacement of 10 mm and initial velocity of 250 mm/s. Find the displacement of the system at t = 1.0 s. Also find the maximum displacement of the system. Neglect damping.

3. A single degree of freedom system with mass 100 kg and stiffness 5000 N/m is subjected to a harmonic load of amplitude 25 N and frequency 6 rad/s. Assuming 10% of critical damping find the steady state amplitude. If the frequency of load is varied, at what frequency the steady state amplitude will reach maximum. Find the maximum value of steady state amplitude also.

4. Find the natural frequencies and mode shapes of the spring-mass system shown in figure. Take m_1 = 20 kg, m_2 = 15 kg, k_1 = 1000 N/m, k_2 = 1200 N/m and k_3 = 900 N/m.



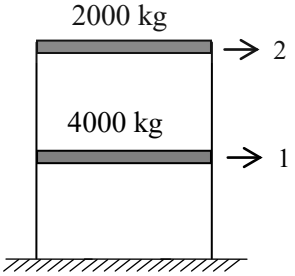
5. Find the natural frequencies and mode shapes of the shear building frame shown. Sketch the mode shapes. Flexural rigidity of the columns $= 2\times10^6$ Nm^2 Workout the mass normalized mode shape vectors also.



6. Determine the free vibration response of a two storied frame having the following properties: Mass of first floor - 1200 kg, Mass of second floor - 800 kg, Stiffness of first storey columns - 50 kN/m and Stiffness of second storey columns - 30 kN/m. The initial displacements of first and second stories are 5 mm and 12 mm respectively.

7. For a two degrees of freedom lumped mass system, $M=\begin{bmatrix} m & 0 \\ 0 & 2m \end{bmatrix}$; $K=\begin{bmatrix} 2k & -k \\ -k & 3k \end{bmatrix}$ and the modal matrix $\Phi=\begin{bmatrix} 1 & 1 \\ 1 & -0.5 \end{bmatrix}$. The natural frequencies are given by $\omega_1^2=\frac{k}{m}$ and $\omega_2^2=\frac{5}{2}\frac{k}{m}$. The first mass of the system is subjected to a harmonic force $P_0\cos(\Omega t)$. Determine the response of each of the masses. Neglect damping.

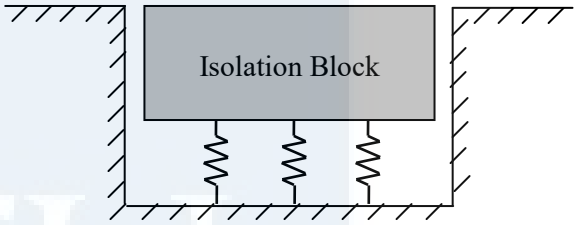
8. For the frame shown in figure the natural frequencies are 15.81 rad/s and 31.62 rad/s. The modal matrix $\Phi=\begin{bmatrix} 1 & 1 \\ 2 & -1 \end{bmatrix}$. Obtain the response of the floors due to a constant ground acceleration of 2 m/s^2. Also, calculate



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 $\overline{m}$ 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 sate 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.

Lecture Plan – Structural Dynamics

Module	Topic	Course Outcomes addressed	No. of Lectures
1	**Module I : Total lecture hours : 10**		
1.1	Introduction to structural dynamics and its importance in Civil Engineering. Dynamic Load, Parameters of dynamic system	CO1	1
1.2	D'Alembers's principle, Equation of motion of SDOF system. Undamped free vibration analysis, concept of natural frequency	CO1,CO2	1
1.3	Modeling systems as SDOF spring-mass model, estimation of stiffness, determination of natural frequency	CO2, CO3	2
1.4	Free vibration response of undamped SDOF systems	CO4	1
1.5	Damped free vibration analysis – concept of critical damping and damping ratio, underdamped and overdamped systems	CO1, CO4	1
1.6	Free vibration response of damped SDOF systems – measurement of damping – logarithmic decrement.	CO1, CO3, CO4	1
1.7	Response of damped SDOF systems to harmonic loading – transient state and steady state responses. Response of undamped SDOF systems to harmonic loading.	CO1, CO4	2
1.8	Steady state amplitude, Dynamic magnification factor, concept of resonance, frequency response plot of SDOF systems.	CO1, CO4	1
2	**Module II : Total lecture hours : 10**		
2.1	Response of undamped and damped SDOF systems to rectangular load.	CO4	1
2.2	Response of undamped and damped SDOF systems to triangular load.	CO4	2
2.3	Response of undamped and damped SDOF systems to half sine pulse.	CO4	1
2.4	Impulse response function for undamped and damped systems Response to general load – concept of Duhamel's integral.	CO1, CO4	1
2.5	Response of undamped and damped SDOF systems to support motion.	CO4	2
2.6	Vibration isolation – force and displacement isolation, Transmissibility ratio.	CO1, CO5	2

2.7	Design of vibration isolation systems	CO5	1
3	**Module III : Total lecture hours : 10**		
3.1	Multi-degree of freedom (MDOF) systems- examples, Lumped mass systems, Shear building frames	CO1, CO4	1
3.2	Modelling of MDOF systems, Equation of motion	CO2, CO3	2
3.3	Undamped free vibration analysis, Natural frequencies and mode shapes, orthogonality of mode shapes	CO1, CO4	3
3.4	Mode superposition method - Free vibration response of undamped MDOF systems	CO1, CO4	2
3.5	Mode superposition method -Free vibration response of damped MDOF systems, concept of modal damping.	CO1, CO4	2
4	**Module IV : Total lecture hours : 8**		
4.1	Forced vibration analysis - Mode superposition method.	CO1, CO4	1
4.2	Response of MDOF systems subjected to harmonic load. Maximum modal responses and modal combination using SRSS rule.	CO1, CO4	3
4.3	MDOF system subjected to support motion – Equation of motion.	CO2	1
4.4	Response of shear building frames subjected to support acceleration - maximum floor response using SRSS rule.	CO2, CO4	2
4.5	Concept of frequency response function (FRF) of MDOF systems.	CO1	1
5	**Module V : Total lecture hours : 7**		
5.1	Introduction to earthquake analysis, Response spectrum – concept, Development of response spectrum	CO1	1
5.2	Response spectrum analysis of MDOF systems.	CO4	2
5.3	Distributed parameter systems, Differential equation for beam flexure (elementary case) and its solution	CO1, CO6	2
5.4	Undamped free vibration analysis of simply supported beam – natural frequencies and mode shapes	CO6	1
5.5	Undamped free vibration analysis of beams with different boundary conditions (formulation only)	CO6	1

MODEL QUESTION PAPER

Reg.No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CET393

Course Name: STRUCTURAL DYNAMICS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions; each question carries 3 marks.

1. a) Explain critically damped, over damped and under damped systems.
   b) Distinguish between 'transient state' and 'steady state' responses.
   c) What is 'impulse response function'? What is its significance?
   d) Define 'Transmissibility' and explain its use in the design of vibration isolation systems.
   e) What do you mean by shear building frames?
   f) Explain orthogonality of mode shapes.
   g) Explain mode superposition method of analysis.
   h) Derive the equation of motion of a two storied shear building frame subjected to support motion.
   i) What is earthquake response spectrum?
   j) Derive the partial differential equation governing the flexural vibration of beams. Neglect damping and effect of axial force.

(10×3 marks = 30 marks)

PART B

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

Module I

2. A free vibration test is conducted on an empty elevated water tank. A cable attached to the tank applies a horizontal force of 100 kN and pulls the tank horizontally by 40 mm. The cable is suddenly cut and the resulting free vibration is recorded. At the end of four complete cycles, the time is 2 s and the amplitude is 25 mm. From these data compute the following: (a) damped natural frequency, (b) damping ratio, (c) effective stiffness, (d) effective mass and (e) amplitude of displacement after 10 cycles.

3. A portable harmonic loading machine is used to conduct a test on a single storied building. Harmonic loads of magnitude 2000 N are applied at the floor level at two different frequencies. The data is given below.

Frequency of load(rad/s)	Response Amplitude(cm)	Phase angle(degree)

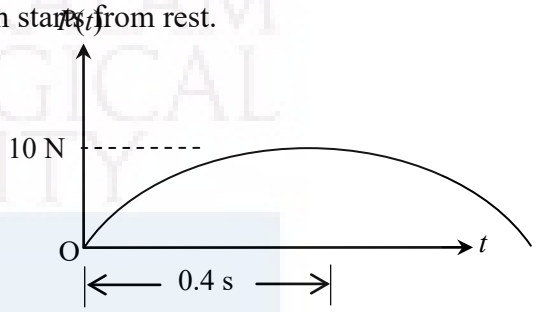
8	1.50	7
10	2.25	13

Estimate the mass, stiffness and damping of the system assuming it as a single degree of freedom system

Module II

4. A single degree of freedom system with m = 10 kg and k = 1.2 kN/m is subjected to a half sine load as shown in figure. Find expressions for the displacement of the system for t<0.4 s and t>0.4 s. Neglect damping. Assume that the system starts from rest.

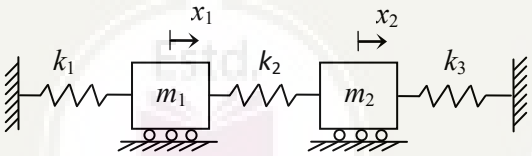
What is the displacement at t = 0.4 s ?



5. A sieving machine weighs 2500 kg and when operating at full capacity, it exerts a harmonic force of 3 kN amplitude at 20 Hz on its supports. After mounting the machine on spring-type vibration isolators, it was found that the amplitude of the harmonic force exerted on the supports had been reduced to 250 N. Determine the stiffness of the isolator springs. Assume damping as 10% of critical.

Module III

6. Find the natural frequencies and mode shapes of the spring-mass system shown in figure. Take m_1 = 20 kg, m_2 = 15 kg, k_1 = 1000 N/m, k_2 = 1200 N/m and k_3 = 900 N/m.



7. Determine the free vibration response of a two storied frame having the following properties: Mass of first floor - 1200 kg, Mass of second floor - 800 kg, Stiffness of first storey columns - 50 kN/m and Stiffness of second storey columns - 30 kN/m. The initial displacements of first and second stories are 5 mm and 12 mm respectively.

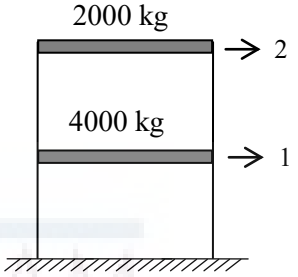
Module IV

8. For a two degrees of freedom lumped mass system,

$M = \begin{bmatrix} m & 0 \\ 0 & 2m \end{bmatrix}$; $K = \begin{bmatrix} 2k & -k \\ -k & 3k \end{bmatrix}$ and the modal matrix $\Phi = \begin{bmatrix} 1 & 1 \\ 1 & -0.5 \end{bmatrix}$. The natural frequencies are given by $\omega_1^2 = \frac{k}{m}$ and $\omega_2^2 = \frac{5}{2}\frac{k}{m}$. The first mass of the system is subjected

to a harmonic force $P_0 \cos(\Omega t)$. Determine the response of each of the masses. Neglect damping.

9. For the frame shown in figure the natural frequencies are 15.81 rad/s and 31.62 rad/s. The modal matrix $\Phi = \begin{bmatrix} 1 & 1 \\ 2 & -1 \end{bmatrix}$. Obtain the response of the floors due to a constant ground acceleration of 2 m/s^2. Also, calculate the floor displacements at $t = 1$ s.



Module V

10. Explain response spectrum analysis of MDOF shear building frames subjected to earthquake ground acceleration. Derive the relevant equations.
11. Find the first three natural frequencies and mode shapes of a simply supported beam of span L having uniform flexural rigidity EI and mass $\overline{m}$ per unit length. Sketch the mode shapes also.

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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: CET302Structural 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 applyit for problemsin 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:

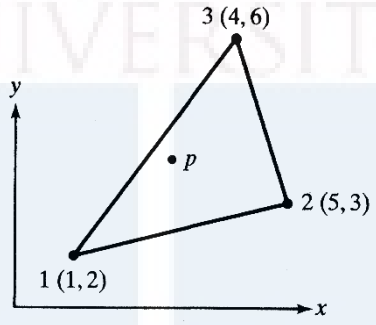
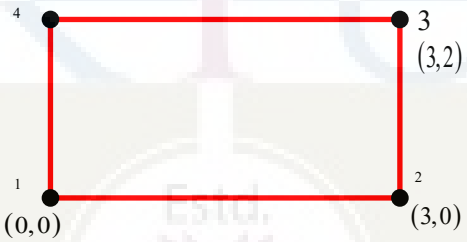
Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

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.

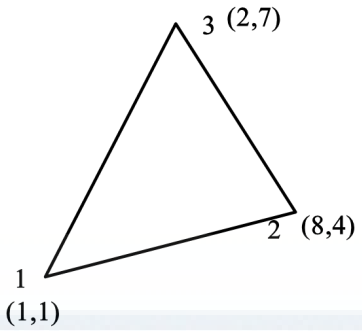
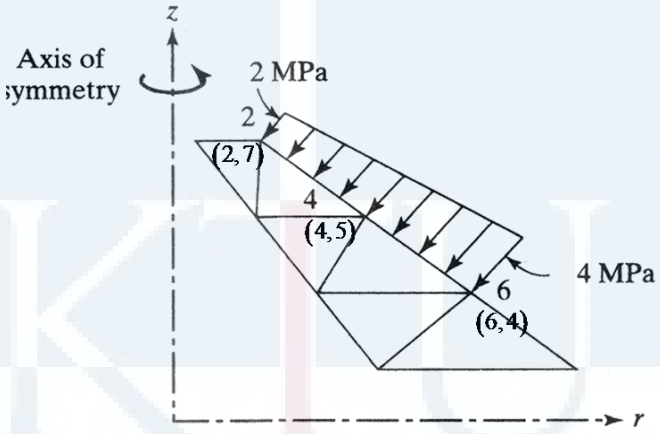
Course Level Assessment Questions

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. $u''(x)+u(x)+x=0 \quad 0<x<1$ $u(0)=0 \qquad u(1)=0$ (a) Assume a quadratic polynomial as a trial solution. (b) Assume a cubic polynomial as a trial solution.
3.	Find a one-parameter approximate solution of the nonlinear equation $$-2u\frac{d^2u}{dx^2}+\left(\frac{du}{dx}\right)^2=4 \quad \text{for} \quad 0<x<1,$$ 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.

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. $$x^2\frac{d^2u}{dx^2}+2x\frac{du}{dx}-xu+4=0 \qquad 1<x<3$$ $$u(1)=1 \qquad \frac{du(3)}{dx}-2u(3)=2$$ (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.

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: $(a)\ I=\int_{0.2}^{0.8} e^{-2x}\tan x\,dx \quad (b)\ I=\int_{-2}^{2}\frac{dx}{1+x^2}$ $(c)\ I=\int_{-1}^{1}\int_{-1}^{1}(t^3+s^2)\,ds\,dt \quad (d)\ I=\int_{-1}^{1}\int_{-1}^{1} x\sin\left(x+y^2\right)dx\,dy$
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?

SYLLABUS

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. Gallaghar, 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

MODEL QUESTION PAPER

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

Answer all questions; each question carries 3 marks.

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?

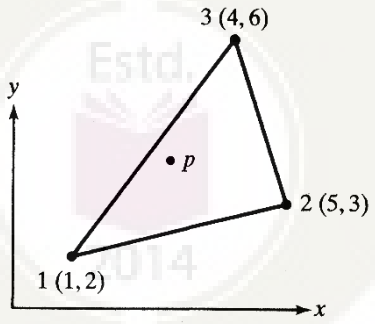
(10×3 marks = 30 marks)

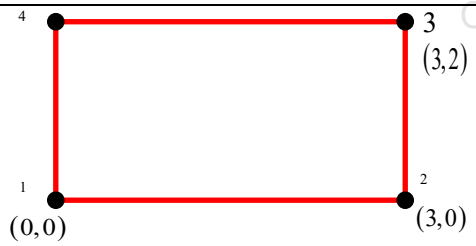
PART B

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

Module I

2.	Using the Galerkin method obtain an approximate solution to the following boundary value problem. $u''(x)+u(x)+x=0 \quad 0<x<1$ $u(0)=0 \qquad u(1)=0$ (a) Assume a quadratic polynomial as a trial solution. (b) Assume a cubic polynomial as a trial solution. (2×7=14 marks)
3.	Find a one-parameter approximate solution of the nonlinear equation

	$$-2u\frac{d^2u}{dx^2}+\left(\frac{du}{dx}\right)^2=4 \quad \text{for} \quad 0<x<1,$$ 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. (14 marks)
	Module II
4.	Derive the element stiffness equations for an axial deformation problem, using variational approach. (14 marks)
5	(a) Obtain the weak form of the following boundary value problem. $$x^2\frac{d^2u}{dx^2}+2x\frac{du}{dx}-xu+4=0 \qquad 1<x<3$$ $$u(1)=1 \qquad \frac{du(3)}{dx}-2u(3)=2$$ (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. (2×7=14 marks)
	Module III
6.	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.  (2×7=14 marks)
7.	Get the explicit shape functions for the rectangular element shown in Figure 3, using Lagrange formulae.



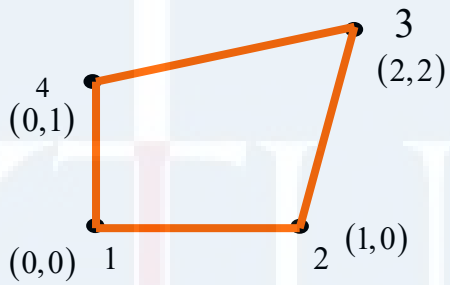
(14 marks)

Module IV

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

(14 marks)

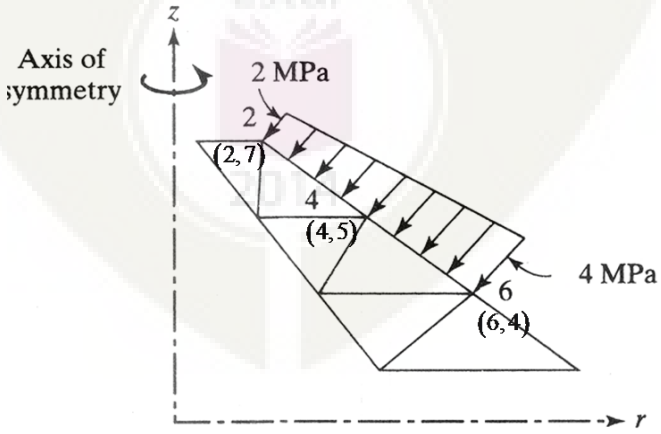
9. Get the explicit isoparametric shape functions for the quadrilateral element shown in Figure 4. Check the validity of isoparametric mapping.



(14 marks)

Module V

10. 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.

(2×7=14 marks)

11.	Evaluate the following integrals using two-point Gauss quadrature: $(a)\ I = \int_{1}^{2}\int_{4}^{6} xy\, e^{(x^2+y^2)}\, dxdy \quad (b)\ I = \int_{-2}^{2} \frac{dx}{1+x^2}$ (2×7=14 marks)
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CET395	TRANSPORTATION SYSTEMS MANAGEMENT	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: Objective of the course is to impart an awareness on transportation system management, TSM strategies, promotion of non-transport modes and advanced transit technologies.

Prerequisite: Nil

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

CO 1	Apply a transportation system management strategy based on TSM goal or objective.
CO 2	Recommend methods to manage a transit system to improve its management efficiency.
CO 3	Recommend measures for the promotion of non-transport modes for a transportation system based on a goal or objective.
CO 4	Assess the suitability of advanced transit technologies in a transportation system.

Mapping of course outcomes with program outcomes

	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	1				2		1			1	2
CO 2	2	1				2		1			1	2
CO 3	1					2	3	1			1	2
CO 4	1				1	2	1	1	1		1	2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (marks)
	Test 1 Marks	Test 2 Marks	
Remember	**10**	**10**	**40**
Understand	**10**	**10**	**40**
Apply	**5**	**5**	**20**
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:

The question consists of two parts- Part A and Part B. Part A consists of 10 questions with 3 marks for each (two questions from each module). Part B consists of two questions from each module, out of which one has to be answered. Each question carries 14 marks and can have maximum 2 subdivisions.

Sample Course Level Assessment Questions:

Course Outcome 1 (CO1): Recommend and discuss two methods for reducing peak period traffic?

Course Outcome 2 (CO2): Identify the issues of multi-modal coordination?

Course Outcome 3 (CO3): As per IRC code, describe the features adopted for bicycle tracks to popularise bicycle traffic in an Indian urban area.

Course Outcome 4 (CO4): Discuss on whether Indian population would adapt to the various advanced transit measures popular in many developed nations.

Syllabus

Module 1

System approach to Transportation Planning; The need for TSM, Long range verses TSM Planning TSM characteristics: TSM planning cycle, TSM strategies, Objectives and Philosophy; Relevance of TSM actions in Indian context. Measures for Improving vehicular flow – one-way Streets, Signal Improvement, Transit Stop Relocation, Parking Management, Reversible lanes-Reducing Peak Period Traffic – Strategies for working hours, Congestion Pricing; Traffic calming measures

Module 2

Public Transport: Preferential Treatment to high Occupancy Vehicles; Transit system operations, Service and characteristics, Transit Service Improvement Measures; Car Pooling; Transit Management Improvement Measure; Multi-Modal Coordination; Transit and Para transit integration;

Module 3

Bus Route Network Planning and Management: Type of Bus Route Networks; Suitability for a given Urban Area; Types of routes – Corridor routes, activity routes and residential routes; Issues in route networks evaluation – number of route, length of route; Route alignment methods; service coverage and accessibility index.

Module 4

Local area traffic management: Promotion of Non – motorised modes: Measures to promote; Pedestrianisation: Pedestrian facilities and management. Bicycle Transportation – advantages; Planning Bicycle Facilities Junction Treats for cycle tracks;LOS criteria for Pedestrian and bicycle Facilities.

Module 5

Advanced Transit Technologies: Conventional and Unconventional Systems; Rapid Transportation System; New technologies – LRT, monorail, Automated Highways- Hovercraft; System Characteristics and Suitability.

Text Books :

1. C. J. Khisty and B. K. Lall, Transportation Engineering: An Introduction, Prentice- Hall India, 2003.
2. Transportation Demand Management (TDM) Encyclopedia, Victoria Transport Policy Institute Canada, 2006.

References:

1. Transportation Engineering and Planning, by C. S. Papacostas and P. D. Prevedouros, PrenticeHall of India Private Limited2001
2. Roger P. Roess, William R.McShane & Elena S.Prassas, Traffic Engineering, Prentice-Hall, 1990.

Course Content and lecture Schedule:

No.	Topic	Course Outcome	No. of Hrs
1	**Module 1**		Total: 9
1.1	System approach to Transportation Planning; The need for TSM, Long range verses TSM Planning	CO1	1
1.2	TSM characteristics: TSM planning cycle, TSM strategies, Objectives and Philosophy; Relevance of TSM actions in Indian context.	CO1	1
1.3	Measures for Improving vehicular flow – one-way Streets, Signal Improvement, Transit Stop Relocation, Parking Management, Reversible lanes- Reducing Peak Period Traffic –	CO1	7

	Strategies for working hours, Congestion Pricing.		
2	**Module 2**		Total: 9
2.1	Public Transport: Preferential Treatment tohigh Occupancy Vehicles; Transit system operations, Service and characteristics, Transit Service Improvement Measures; Car Pooling;	CO2	4
2.2	Transit Management Improvement Measure; Multi-Modal Coordination; Transit and Para transit integration;	CO2	5
3	**Module 3**		Total: 9
3.1	Bus Route Network Planning and Management: Type of Bus Route Networks; Suitability for a given Urban Area;	CO2	2
3.2	Types of routes – Corridor routes, activity routes and residential routes;	CO2	2
3.3	Issues in route networks evaluation – number of route, length of route;	CO2	2
3.4	Route alignment methods; service coverage and accessibility index.	CO2	3
4	**Module 4**		Total: 9
4.1	Local area traffic management: Promotion of Non – motorised modes: Measures to promote;	CO3	1
4.2	Pedestrianisation: Pedestrian facilities and management. IRC codes.	CO3	2
4.3	Bicycle Transportation – advantages; Planning Bicycle Facilities Junction Treats for cycle tracks; IRC codes for bicycle facilities.	CO3	4
4.4	LOS criteria for Pedestrian and bicycle Facilities.	CO3	2
5	**Module 5**		Total: 9
5.1	Advanced Transit Technologies: low carbon vehicles; Automated Highways: System Characteristics and Suitability, Electric vehicles, Automated vehicles: Planning, infrastructure and implementation; issues.	CO4	4
5.2	Rapid Transportation System; New technologies – LRT, monorail, Bus rapid transit system (BRTS), Rail rapid transit system(RRTS).	CO4	5

Model Question Paper

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

Course Code: **CET395**

Course Name: **TRANSPORTATION SYSTEMS MANAGEMENT**

Marks:100 Duration: 3 hrs

PART A
(Answer all Questions: Each question carries 3 marks)

1 Mention the need for Transportation System Management.
2 Discussabout the relevance of TSM actions in Indian context?
3 What are the issues related to transit and para transit integration?
4 Discuss about carpooling.
5 What are the strategies adopted for fixing suitable bus network for a given Urban Area?
6 Comment on how to arrive at an accessibility index for a transit route.
7 Suggest the measures to be taken to promote NMT in Indian cities.
8 What considerations are to be made for planning proper bicycle Facilities for an urban area?
9 Mention some important features suggested for automated highways.
10 Why should planners recommend BRTS for urban areas?

(3 x 10=30 marks)

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PART B
(Answer one full question from each module)

11 a.		Describe the system approach to transportation planning	7
	b.	What are reversible lanes? How does it help to improve traffic flow?	7
		OR	
12 a.		Mention the objectives of TSM?	7
	b.	How is congestion pricing carried out to improve traffic flow?	7
13 a.		What are the service characteristics of transit operations?	7
	b.	List out the five pillars of multi-modal integration? Explain each.	7
		OR	
14		List out the preferential treatments to High Occupancy Vehicles. Explain any	14

five in detail.

15	Compare and contrast the different route adopted under network planning strategies.	14
	OR	
16 a.	How do you evaluate the effectiveness of bus route network?	7
b.	Describe in detail any method adopted by planners to align route in the urban road networks.	7
17 a.	List down the characteristics of Non – motorised modes of traffic.	7
b.	How can the LOS criteria for Pedestrian formulated?	7
	OR	
18 a	Suggest the modifications to be adopted in an urban roadway to enhance the pedestrian facilities in reference to the IRC codes.	7
b.	Discuss the Junction Treatments to be facilitated for laying cycle tracks.	7
19 a.	What are the infrastructural facilities required for a properly planned electric transit vehicle system in a typical Indian city	7
b.	Compare and contrast any two popular Rapid Transportation Systems.	7
	OR	
20 a.	What are the infrastructural and service characteristics advised for a typical Indian city to be employed with an automatic highway?	7
b.	What are the measures that can be adopted for enhancing the usage of rail as a transit mode?	7

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

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

Prerequisite: CET 305 : GEOTECHNICAL ENGINEERING II

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

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

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation (CIE) Pattern :

Attendance : 10 Marks

Continuous Assessment Test (2 numbers) : 25 Marks

Assignment/Quiz/Course project : 15 Marks

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

Course Level Assessment Questions

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

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

1. Analyze slope stability of earth dams

Course Outcome 3 (CO3):

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

Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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

SYLLABUS

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

Text Books :

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

References:

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

Course Contents and Lecture Schedule:

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

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

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

Model Question Paper
QP CODE:

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

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

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

Max. Marks: 100 Duration: 3 hours

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

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

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

Module – 1

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

Module – 2

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

Module – 3

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

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

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

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

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

Module – 4

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

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

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

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

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

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

Module – 5

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

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

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

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

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					

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 397
Ground Water Hydrology
(Course plan)

Module	Topic	Course outcome addressed	No of Hours
Module I (10 Hours)			
1.1	Vertical distribution of ground water-Types of geologic formations	CO1	1
1.2	Properties of aquifer related to storage and transmissivity of water	CO1	1
1.3	Darcy's law, Steady unidirectional flow	CO1	1
1.4	Steady flow in a homogenous aquifer	CO1	1

1.5	Problems from unidirectional flow	CO1	2
1.6	Aquifer with recharge	CO1	1
1.7	Flow into infiltration galleries	CO1	1
1.8	Problems	CO1	2
Module II (8 Hours)			
2.1	Partial differential equation governing unsteady ground water flow	CO2	1
2.2	Unsteady radial flow towards well	CO2	1
2.3	Evaluation of aquifer parameters- Theis method	CO2	1
2.4	Evaluation of aquifer parameters- Jacob's method	CO2	1
2.5	Evaluation of aquifer parameters- Chow's method	CO2	1
2.6	Problems- Evaluation of aquifer parameters	CO2	3
Module III (11 Hours)			
3.1	Well flow near aquifer boundaries	CO3	1
3.2	Image well system	CO3	1
3.3	Method of images –particular cases	CO3	1
3.4	Problems from method of images	CO3	2
3.5	Surface investigation of ground water	CO3	1
3.6	Electrical resistivity method	CO3	1
3.7	Seismic refraction method	CO3	1
3.8	Determination of aquifer thickness of horizontal aquifers	CO3	1
3.9	Problems- resistivity method, seismic refraction	CO3	2
Module IV (9 Hours)			
4.1	Quality of ground water –Graphical representations	CO4	1
4.2	Pollution of ground water-sources	CO4	1
4.3	Distribution and evaluation of ground water pollution	CO4	1
4.4	Sea water intrusion-Ghyben-Herzberg equation	CO4	1
4.5	Sea water-fresh water interface	CO4	1
4.6	Length of intrusion	CO4	1
4.7	Upconing , Sea water intrusion- preventive measures	CO4	1
4.8	Problems- Sea water intrusion	CO4	2
Module V (7 Hours)			
5.1	Artificial recharge of ground water- different techniques	CO5	1
5.2	Modelling of ground water flow	CO5	1
5.3	Governing equations of ground water flow and boundary conditions	CO5	1
5.4	Solution of partial differential equation of ground water flow for 1D steady ground water flow in homogenous aquifer using finite difference method	CO5	4

CET 397: Ground Water Hydrology
Syllabus

Module I

Vertical distribution of groundwater- Types of geologic formations, Properties of aquifer related to storage and transmissivity of water, Darcy's law, Steady unidirectional flow- steady flow in a homogenous aquifer- aquifer with recharge- flow into infiltration galleries. (Problems from unidirectional flow)

Module II

Partial differential equation governing unsteady groundwater flow- unsteady radial flow towards well. Evaluation of aquifer parameters by Theis, Jacob's and Chow's method. (Problems from evaluation of aquifer parameters)

Module III

Well flow near aquifer boundaries- Image well system. Method of images- Practical cases (Problems from method of images). Surface investigation of ground water- different methods- electrical resistivity method, seismic refraction method- determination of aquifer thickness of horizontal aquifers (Problems from resistivity method, seismic refraction)

Module IV

Quality of ground water- Graphical representations. Pollution of ground water- sources, distribution and evaluation of ground water pollution (Brief description only). Sea water intrusion- Ghyben-Herzberg equation, sea water-fresh water interface, length of intrusion, upconing, preventive measures.(Problems from sea water intrusion)

Module V

Artificial recharge of ground water-different techniques. Modelling of ground water flow- governing equations of ground water flow and boundary conditions (basic ideas only), solution of partial differential equation of ground water flow for 1D steady ground water flow in homogenous aquifers (confined and unconfined) using finite difference method (uniform mesh interval only)

Text Books:

1. D.K. Todd, "Ground Water Hydrology", Wiley International Ed; Toppan &Company Ltd, Tokyo, 1995.
2. H.M. Raghunath, "Groundwater", New Age International Publishers, New Delhi, 2007.
3. A.K. Rastogi, "Numerical Ground Water Hydrology", Penram International Publishers, Mumbai

References:

1. Karanth, "Ground Water Assessment, Development and Management" Tata McGraw Hill publishing company Ltd.
2. "Ground Water Manual", A Water Resources Technical Publication.
3. S.P Garg, "Ground Water and tube wells", Oxford &IBH Publishing Company.
4. Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, " Irrigation and Water Power
   Engineering", Laxmi Publications (P) Ltd. 2009
5. Herman Bouwer, "Ground Water Hydrology", MC Graw Hill Kogakusha Ltd.
6. H.M. Raghunath, "Ground Water Hydrology", Wiley Eastern Limited.
7. Neven Kresic, "Hydrogeology and Ground Water modeling", CRC press, Taylor&Francis group, 2007.
8. Freeze and Cherry, "Ground Water", Prentice Hall

Course Code: CET 397
Ground Water Hydrology
(Course Level Assessment Questions)

Qn No	Question	Marks	Course outcome (CO) Assessed
	Part A **(Answer ALL Questions)**		
1	Explain different properties of aquifer	3	CO1
2	What is an infiltration gallery? Explain with figure.	3	CO1
3	Briefly explain Theis method of estimation of aquifer parameters	3	CO2
4	What are the assumptions in the derivation of partial differential equation of unsteady radial flow towards wells?	3	CO2
5	Find the number of image wells and locate the image wells when the aquifer is delimited by two converging recharge boundaries at right angles.	3	CO3
6	What are the applications of electrical resistivity method?	3	CO3
7	What are the different sources of pollution of ground water? Explain briefly	3	CO4
8	Explain upconing with neat sketch	3	CO4
9	Write the equations for the second order head gradient of an aquifer using central, forward and backward difference schemes	3	CO5
10	Write the governing equations of groundwater flow and boundary conditions	3	CO5
	Part B **(Answer ANY ONE FULL question from each module)**		
	Module I		
11(a)	Explain different types of aquifer with neat sketches	7	CO1
11(b)	In a field test, time of 6 hour was required for a tracer to	7	CO1

<table>
<tr><td></td><td>travel between two observation wells 42 m apart. If the difference in water-table elevations in these wells were 0.85 m and the porosity of the aquifer is 20%, calculate the coefficient of permeability of the aquifer.</td><td></td><td></td></tr>
<tr><td>12(a)</td><td>State Darcy’s law and its limitations</td><td>4</td><td>CO1</td></tr>
<tr><td>12(b)</td><td>Sketch a typical infiltration gallery. Derive the equation for discharge per unit length of the infiltration gallery and phreatic surface by making suitable assumptions.</td><td>10</td><td>CO1</td></tr>
<tr><td></td><td>Module II</td><td></td><td></td></tr>
<tr><td>13(a)</td><td>Derive partial differential equation for unsteady ground water flow</td><td>10</td><td>CO2</td></tr>
<tr><td>13(b)</td><td>A well of 30 cm diameter is located in a confined aquifer of transmissibility 500m^2/day and storage coefficient of 0.005. What pumping rate will have to be adopted if the drawdown at the well is not to exceed 10 m in 2 days.</td><td>4</td><td>CO2</td></tr>
<tr><td>14(a)</td><td>The time drawdown data recorded at an observation well situated at a distance of 50 m from the pumping well is given below.
<table>
<tr><td>Time (min)</td><td>Drawdown (m)</td></tr>
<tr><td>1.5</td><td>0.15</td></tr>
<tr><td>3</td><td>0.6</td></tr>
<tr><td>4.4</td><td>1</td></tr>
<tr><td>6</td><td>1.4</td></tr>
<tr><td>10</td><td>2.4</td></tr>
<tr><td>20</td><td>3.7</td></tr>
<tr><td>40</td><td>5.1</td></tr>
<tr><td>100</td><td>6.9</td></tr>
</table>
If the well discharge is 1.8 m^3/min, calculate the transmissibility and storage coefficient of the aquifer using modified Theis method.</td><td>9</td><td>CO2</td></tr>
<tr><td>14(b)</td><td>Describe the method for the estimation of aquifer parameters by Chow’s method.</td><td>5</td><td>CO2</td></tr>
<tr><td></td><td>Module III</td><td></td><td></td></tr>
<tr><td>15 (a)</td><td>Describe the seismic refraction method for groundwater investigation with a neat sketch.</td><td>7</td><td>CO3</td></tr>
<tr><td>15(b)</td><td>An aquifer is delineated by two converging barrier boundaries, the angle of wedge being 45^0.Compute the number of image wells associated with the wedge shaped</td><td>7</td><td>CO3</td></tr>
</table>

	boundary system and mark them neatly in a sketch.		
16 (a)	In a seismic refraction survey for locating an aquifer, slopes of 1.66×10^{-3} and 0.000625 s/m were noted from the time-distance plots. If the cross-over distance is 20.76 m, compute the depth to the aquifer, the critical shot-geophone distance, and the correct angle of incidence for the refraction along the interface.	5	CO3
16 (b)	A 30cm well is pumped at the rate of 1000 lpm. The transmissibility of the aquifer is $0.015 m^2/s$. If the well is located at a distance of 120m from a stream, what should be the drawdown (i) In the pumping well (ii) In an observation well 100m away from the pumping well on the side opposite to the stream (iii) In an observation well 85m away from the pumping well, on a line parallel to the stream.	9	CO3
	Module IV		
17(a)	Derive the relationship between length of interface and freshwater discharge in a confined aquifer.	8	CO4
17(b)	Explain different water quality plots with neat sketches	6	CO4
18(a)	Describe the preventive measures to control saltwater intrusion into coastal aquifers with neat sketches.	7	CO4
18(b)	By conductivity measurements in a well in a coastal aquifer extending 4 km along the shore, the interface was located at a depth of 20 m below m.s.l. at 100 m from the shore, inland. The depth of the homogenous aquifer is 30 m below m.s.l. and has a permeability of 50 m/day. What is the rate of fresh water flow into the sea and the width of gap at the shore bottom through which it escapes into the sea? What is the position of the toe of the saltwater wedge? Use Glover's method.	7	CO4
	Module V		
19 (a)	Explain different techniques of artificial recharge of ground water with neat sketches.	8	CO5
19 (b)	Find the numerical value of the third and fourth order aquifer head gradient by the forward, backward and	6	CO5

	central difference method assuming uniform head distribution in a confined aquifer between two wells located 4 Km apart with piezometric levels of 100 m and 102 m respectively. Take these two wells as the extreme nodes.		
20 (a)	One dimensional steady state flow is happening in a confined aquifer with transmissivity T. The aquifer is bounded by an impervious boundary to the left and a constant head boundary to the right. Ground water flows into the aquifer due to a constant recharge Q through an aquitard. Assuming Q=0.0005m/day, T= 500 m/day, thickness of aquifer b=100m, length of aquifer L= 5 Km, Constant head of right boundary H=100 m, find the head at different nodes using central difference scheme.(Take discretization interval as 1250 m)	10	CO5
20 (b)	Write any six applications of ground water models.	4	CO5

Model Question Paper

Pages: 3

Reg No.:…….. QP CODE:……..

Name:……

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

Course Code: CET 397

Ground Water Hydrology

Max. Marks: 100 Duration: 3 hours

Part A

(Answer all questions; each question carries 3 marks)

1. Explain different properties of aquifer
2. What is an infiltration gallery? Explain with figure.
3. Briefly explain Theis method of estimation of aquifer parameters
4. What are the assumptions in the derivation of partial differential equation of unsteady radial flow towards wells?
5. Find the number of image wells and locate the image wells when the aquifer is delimited by two converging recharge boundaries at right angles.
6. What are the applications of electrical resistivity method?
7. What are the different sources of pollution of ground water? Explain briefly
8. Explain upconing with neat sketch
9. Write the equations for the second order head gradient of an aquifer using central, forward and backward difference schemes
10. Write the governing equations of groundwater flow and boundary conditions

Part B

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

Module I

11 (a) Explain different types of aquifer with neat sketches (7 Marks)

(b) In a field test, time of 6 hour was required for a tracer to travel between two observation wells 42 m apart. If the difference in water-table elevations in these wells were 0.85 m and the porosity of the aquifer is 20%, calculate the coefficient of permeability of the aquifer. (7 Marks)

OR

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

(b) Sketch a typical infiltration gallery. Derive the equation for discharge per unit length of the infiltration gallery and phreatic surface by making suitable assumptions. (10 Marks)

Module II

13(a) Derive partial differential equation for unsteady ground water flow (10 Marks)

(b) A well of 30 cm diameter is located in a confined aquifer of transmissibility 500m^2/day and storage coefficient of 0.005. What pumping rate will have to be adopted if the drawdown at the well is not to exceed 10 m in 2 days. (4 Marks)

OR

14.(a) The time drawdown data recorded at an observation well situated at a distance of 50 m from the pumping well is given below.

Time (min)	Drawdown (m)
1.5	0.15
3	0.6
4.4	1
6	1.4
10	2.4
20	3.7
40	5.1
100	6.9

If the well discharge is 1.8 m^3/min, calculate the transmissibility and storage coefficient of the aquifer using modified Theis method. (9 Marks)

(b) Describe the method for the estimation of aquifer parameters by Chow's method.

(5 Marks)

Module III

15. (a) Describe the seismic refraction method for groundwater investigation with a neat sketch. (7 Marks)

(b) An aquifer is delineated by two converging barrier boundaries, the angle of wedge being 45^0.Compute the number of image wells associated with the wedge shaped boundary system and mark them neatly in a sketch. (7 Marks)

OR

16. (a) In a seismic refraction survey for locating an aquifer, slopes of 1.66×10^{-3} and 0.000625 s/m were noted from the time-distance plots. If the cross-over distance is 20.76 m, compute the depth to the aquifer, the critical shot-geophone distance, and the correct angle of incidence for the refraction along the interface.

(5 Marks)

(b) A 30cm well is pumped at the rate of 1000 lpm. The transmissibility of the aquifer is $0.015 m^2/s$. If the well is located at a distance of 120m from a stream, what should be the drawdown

(i) In the pumping well

(ii) In an observation well 100m away from the pumping well on the side opposite to the stream

(iii) In an observation well 85m away from the pumping well, on a line parallel to the stream. (9 Marks)

Module IV

17 (a) Derive the relationship between length of interface and freshwater discharge in a confined aquifer. (8 Marks)

(b) Explain different water quality plots with neat sketches . (6 Marks)

OR

18 (a) Describe the preventive measures to control saltwater intrusion into coastal aquifers with neat sketches. (7 Marks)

(b) By conductivity measurements in a well in a coastal aquifer extending 4 km along the shore, the interface was located at a depth of 20 m below m.s.l. at 100 m from the shore, inland. The depth of the homogenous aquifer is 30 m below m.s.l. and has a permeability of 50 m/day. What is the rate of fresh water flow into the sea and the width of gap at the shore bottom through which it escapes into the sea? What is the position of the toe of the saltwater wedge? Use Glover's method. (7 Marks)

Module V

19 (a) Explain different techniques of artificial recharge of ground water with neat sketches. (8 Marks)

(b) Find the numerical value of the third and fourth order aquifer head gradient by the forward, backward and central difference method assuming uniform head distribution in a confined aquifer between two wells located 4 Km apart with piezometric levels of 100 m and 102 m respectively. Take these two wells as the extreme nodes.

(6 Marks)

OR

20.(a) One dimensional steady state flow is happening in a confined aquifer with transmissivity T. The aquifer is bounded by an impervious boundary to the left and a constant head boundary to the right. Ground water flows into the aquifer due to a constant recharge Q through an aquitard. Assuming Q=0.0005m/day, T= 500 m/day, thickness of aquifer b=100m, length of aquifer L= 5 Km, Constant head of right boundary H=100 m, find the head at different nodes using central difference scheme.(Take discretization interval as 1250 m) (10 Marks)

(b) Write any six applications of ground water models. (4 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

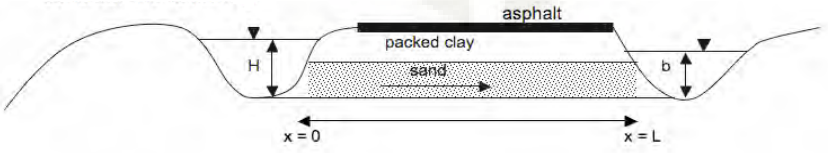
End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each 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: Tolearn how to build a model to represent physical transport of pollutants in environment

1	Explain model building procedure
2	What is the flow equation for the following situation? 

3	Discuss how salinity intrusion is modeled

CO3: To simulate pollution transport scenarios in water, air and noise environment

1	The SO2 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 σy= 80m and σz= 120m.
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 kd is 0.4/day, and the reaeration rate coefficient kr 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 m3/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, discreet, 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, discreet, 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^{o} 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 ^{o} at 3 m/s. Given that σy= 150m and σz= 87m (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)

CET495	MODERN CONSTRUCTION MATERIALS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		VAC	3	1	0	4	2019

Preamble: Goal of this course is to expose the students to the recent developments in the modern construction materials, and to introduce the conventional construction materials and their modern use. After this course, students will be able to identify and decide the material most suited for the construction, considering the durability, sustainability and economy in the material selection.

Prerequisite: CET309 Construction Technology and Management

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

CO 1	Identify and select suitable concrete type for a specific construction
CO 2	Characterize various structural materials for construction
CO 3	Select suitable non-structural materials for buildings
CO 4	Ascertain sustainable materials for construction
CO 5	Outline various smart materials suitable for structures

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	1				2	3					3
CO 2	3	1				2	3					3
CO 3	3	1				2	3					3
CO 4	3	1				2	3					3
CO 5	3	1				2	3					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	50
Apply	10	10	10
Analyse			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation (CIE) Pattern :

Attendance : 10 Marks

Continuous Assessment Test (2 numbers) : 25 Marks

Assignment/Quiz/Course project : 15 Marks

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

Course Level Assessment Questions

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

Course Outcome 1 (CO1):

1. Explain the mix composition, properties and uses of high strength concrete.
2. Enumerate the various advantages of using high strength concrete.
3. Describe the properties and uses of fibre reinforced concrete.
4. Write a short note on ready mixed concrete. What are its advantages?

Course Outcome 2 (CO2):

1. Explain the types and properties of structural materials
2. Describe the manufacturing process of various structural materials
3. Enumerate the applications of various structural materials in construction

Course Outcome 3 (CO3):

1. Explain the types and properties of non-structural materials
2. Describe the manufacturing process of various non-structural materials
3. Enumerate the uses and applications of various non-structural materials in construction

Course Outcome 4 (CO4):

1. Explain the pros and cons of various sustainable materials
2. Enumerate the uses and applications of various sustainable materials in construction
3. Define the concepts of life cycle assessment

Course Outcome 5 (CO5):

1. Explain the pros and cons of various smart materials
2. Enumerate the applications of smart materials in construction

Syllabus

Module 1 (Advanced Concrete)

Concrete - special concretes for specific purposes like lightweight concrete, ready mixed concrete, high strength concrete, high performance concrete, self compacting concrete, fibre reinforced concrete, polymer concrete, geopolymer concrete, textile reinforced concrete, ferrocement (brief description of composition, properties, and applications of the above).

Module 2 (Structural Materials)

Bricks, fly ash bricks - Stone; Stabilised mud blocks, soil - cement blocks, calcium silicate bricks, red mud - Wood, Industrial Products which can substitute wood ; particle board, fibre board, hard board, Glulam - Polymers; Fibre reinforced polymers - Metals; Steel ; Aluminium - Bituminous materials – Glass, glass reinforced gypsum – Plastics - jute fibre polymer composite (RFPC)

Module 3 (Non-structural Materials)

Properties and use of conventional and modern waterproofing materials, Conventional and modern insulating materials (thermal, sound and electrical insulating materials). Concept of polymer floor finishes, Paints, tiles, Acoustic Treatment, Dry walls, anchors

Module 4 (Sustainable Materials)

Sustainable Construction Materials - Wood, bamboo, straw bales, earthen materials, glass cullet, copper slag, municipal incinerated bottom ash, recycled aggregates, recycled plastic products, sustainable concretes, biocomposites, thatched roofing, linoleum flooring.

Energy - Definition, Types of Unit Energy Values, Assessment of Energy. (brief discussion only)

Introduction to Life Cycle Assessment (brief discussion only)

Module 5 (Smart and Intelligent Materials)

Types- Neoprene, Bridge pads, thermocole- Smart and Intelligent Materials, Special features:- Shape Memory Alloys (SMAs), Magnetostrictive Materials, Piezoelectric Materials, Electrochromic materials, Green materials including biomaterials, biopolymers, bioplastics– – Case studies showing the applications of smart and Intelligent Materials.

Text/Reference Books:

1. Building Materials, P. C. Varghese, Prentice-Hall India, 2005.
2. Construction materials: Their nature and behaviour, Eds. J.M. Illston and P.L.J. Domone, 3rd ed., Spon Press, 2001.
3. The Science and Technology of Civil Engineering Materials, J.F. Young, S. Mindess, R.J. Gray & A. Bentur, Prentice Hall, 1998
4. Michel S. Mamlouk and John P. Zaniewski, Materials for Civil and Construction Engineers, Prentice Hall.
5. L. Reed Brantley and Ruth T Brantley, Building Materials Technology, McGraw-Hill Publishers
6. Neil Jackson and Ravindra K. Dhir, Civil Engineering Materials, Palgrave Foundations
7. Don A Watson, Construction Materials and Processes, Career Education
8. Gandhi M. V. and B. S. Thompson, Smart Materials and Structures, Chapmann & Hall, London
9. Concrete: Microstructure, properties and materials, P.K. Mehta and P.J.M. Monteiro, McGraw Hill, 2006
10. Properties of concrete, A.M. Neville, Pearson, 2004
11. Shetty M. S., Concrete Technology", S. Chand & Co., 2006
12. Ganapathy, C., Modern Construction Materials, Eswar Press, 2015.
13. Deucher, K.N, Korfiatis, G.P and Ezeldin, A.S, Materials for civil and Highway Engineers, Prentice Hall Inc., 1998.
14. Mamlouk, M.S. and Zaniewski, J.P., Materials for Civil and Construction Engineers, Prentice Hall Inc., 1999.
15. Brain Culshaw – Smart Structure and Materials Artech House – Borton. London-1996.
16. Materials Science and Engineering, V. Raghavan, Prentice Hall, 1990
17. Sandy Halliday, Sustainable Construction, Butterworth-Heinemann, 2008.

Course Contents and Lecture Schedule:

Module	Contents	Outcomes Addressed	Hours
1	**Module 1**		**8**
1.1	Review of properties of concrete, uses of concrete	CO1	1
1.2	lightweight concrete (types, properties and uses)	CO1	1
1.3	ready mixed concrete, high strength concrete, high performance concrete	CO1	1
1.4	self compacting concrete (properties, tests and uses)	CO1	2
1.5	fibre reinforced concrete (properties and applications)	CO1	1
1.6	polymer concrete (types, properties and uses)	CO1	1
1.7	geopolymer concrete (brief description of one part and two part geopolymer concrete, composition, properties, and uses)	CO1	1
1.8	textile reinforced concrete (properties and uses), ferrocement (construction, properties and applications)	CO1	1
2	**Module 2**		**9**
2.1	Bricks, fly ash bricks	CO2	1
2.2	Stone; Stabilised mud blocks, soil - cement blocks, calcium silicate bricks, red mud	CO2	1
2.3	Wood, Industrial Products which can substitute wood ; particle board, fibre board, hard board, Glulam	CO2	1
2.4	Polymers; Fibre reinforced polymers	CO2	1
2.5	Metals; Steel , Aluminium	CO2	1
2.6	Bituminous materials	CO2	1
2.7	Glass, glass reinforced gypsum	CO2	1
2.8	Plastics	CO2	1
2.9	Jute fibre polymer composite (RFPC)	CO2	1
3	**Module 3**		**9**
3.1	Properties and use of conventional and modern waterproofing materials	CO3	1
3.2	Conventional and modern insulating materials (thermal)	CO3	1
3.3	sound and electrical insulating materials	CO3	1
3.4	Concept of polymer floor finishes	CO3	1

3.5	Paints	CO3	1
3.6	Tiles	CO3	1
3.7	Acoustic Treatment	CO3	1
3.8	Dry walls	CO3	1
3.9	Anchors	CO3	1
4	**Module 4**		**9**
4.1	Susainable Construction Materials - Wood, bamboo, straw bales (characteristics, types and uses)	CO4	1
4.2	Earthen materials- rammed earth, earthen bags, mudbrick, adobe, cob, compressed earth block, (characteristics, types and uses)	CO4	1
4.3	Earth shelter technique	CO4	1
4.4	Glass cullet, copper slag, municipal incinerated bottom ash (characteristics and uses)	CO4	1
4.5	Recycled aggregates, recycled plastic products (characteristics, types and uses)	CO4	1
4.6	Sustainable concretes, thatched roofing, linoleum flooring. (characteristics, types and uses)	CO4	1
4.7	Emergy - Definition, Types of Unit Emergy Values	CO4	1
4.8	Assessment of emergy	CO4	1
4.9	Introduction to Life Cycle Assessment (brief discussion)	CO4	1
5	**Module 5**		**9**
5.1	Types- Neoprene	CO5	1
5.2	Bridge pads	CO5	1
5.3	Thermocole	CO5	1
5.4	Smart and Intelligent Materials	CO5	1
5.5	Shape Memory Alloys (SMAs), Magnetostrictive Materials	CO5	1
5.6	Piezoelectric Materials, Electrochromic materials	CO5	1
5.7	Green materials including biomaterials, biopolymers, bioplastics	CO5	2
5.8	Case studies showing the applications of smart and Intelligent Materials.	CO5	2

Model Question Paper
QP CODE:

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

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

Course Code: CET 495
Course Name : MODERN CONSTRUCTION MATERIALS

Max. Marks: 100 Duration: 3 hours

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

1. Enumerate the various advantages of using high strength concrete.
2. State the advantages of self compacting concrete.
3. What is the use of gypsum board in construction?
4. Define dressing of stones
5. Name few commercially available water proofing compounds
6. What is meant by façade material?
7. Explain about linoleum flooring and its sustainability aspects.
8. Enlist the pros and cons of bamboo as a construction material
9. List out the recent smart materials used in building construction
10. What is shape memory alloys?

PART B

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

Module – 1

11. (a) Explain the mix composition, properties and uses of self compacting concrete. (8)
    (b) Write a short note on ready mixed concrete. What are its advantages? (6)

12. (a) Explain the different types, properties and uses of light weight concrete. (8)
    (b) Explain the typical composition of a geopolymer concrete and its advantages. (6)

Module – 2

13. (a) Describe corrosion of steel and the measures adopted for its prevention. (8)

    (b) Explain the different types of glass and its applications in buildings. (6)

14. (a) Detail the types of plastics, its manufacturing process and uses. (8)

    (b) Explore the possibilities of stabilized mud block as a construction material (6)

Module – 3

15. (a) Explain the functions, types and properties of water proofing compounds. (8)

    (b) Critically compare different modern flooring materials. (6)

16. 16. (a) Describe various modern thermal and sound insulating materials. (8)

    (b) Compare "breathing" and "non-breathing" types of paints. What are the considerations in application of these paints to the ceiling under the wet areas and wall surfaces? (6)

Module – 4

17. (a) What are the various eco-friendly materials for green building? (8)

    (b) Discuss the uses of glass cullet in the construction industry. (6)

18. (a) Explain the uses of copper slag as sustainable aggregate. (6)

    (b) How will you improve low-cost rural houses using modern construction materials? (8)

Module – 5

19. (a) Compare Smart and intelligent materials (6)

    (b) Explain the various types of smart materials based on their properties (8)

20. (a) Write an explanatory note on the special features and application of intelligent and smart modern materials (8)

    (b) Evaluate the effects of smart materials on green buildings (6)

CET497	SOIL DYNAMICS AND MACHINE FOUNDATIONS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		VAC	3	1	0	4	2019

Preamble: Goal of this course is to impart to the students, in-depth knowledge about the basic concepts and theories of soil dynamics and machine foundation.

Prerequisite: Geotechnical Engineering - II

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

CO 1	Analyze single degree of freedom systems under vibration using theory of vibrations
CO 2	Evaluate dynamic soil properties using IS procedures
CO 3	Analyze the response of machine foundations
CO 4	Design machine foundation with reciprocating and Impact type of machines
CO 5	Design of wave barriers

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	-	-	-	-	-	-	-	-	-	-

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.

Syllabus

Module 1

Theory of vibrations: Definitions, Single degree freedom system - Free vibration of a spring mass system. Free vibration with viscous damping- Critically damped system, Over damped system, Under damped system. Logarithmic decrement. Forced vibration with damping. Frequency dependent excitation.

Dynamic soil properties: Definition and factors affecting. Determination of dynamic soil properties -Cross hole test, Cyclic plate load test, Block vibration test, Correlations of dynamic soil properties with SPT N value.

Module 2

Analysis of Machine Foundations: Modes of vibrations of a rigid foundation block. Linear Elastic Weightless Spring method of analysis for all modes of vibration- Numerical problems. Concept of elastic Half-space method of analysis.

Module 3

Design of foundation for reciprocating machines: Design of foundations for reciprocating machines (IS method of Design) -design requirements and design procedure for block type foundation-Necessary data, design criteria, permissible amplitude.

Module 4

Design of foundation for Impact type machines-Design criteria and design procedure for block type foundation (IS method). Properties and requirements of cushion pad, Construction criteria of foundations for impact type of machines.

Module 5

Vibration isolation for Machine Foundations: Choice of vibration isolation -IS Guidelines, Active and passive isolation, Transmissibility, Design of wave barriers (open trench), dynamic properties of vibration isolators- coil springs, rubber springs, cork pads, Design procedure for foundations on absorbers .

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	Hours
1		
1.1	**Theory of vibrations:** Definitions, Single degree freedom system	1
1.2	Free vibration of a spring mass system.	1
1.3	Free vibration with viscous damping- Critically damped system, Over damped system, Under damped system	1
1.4	Logarithmic decrement. Forced vibration with damping	1
1.5	Frequency dependent excitation.	1
1.6	**Dynamic soil properties**: Definition and factors affecting	1
1.7	Determination of dynamic soil properties -Cross hole test, Cyclic plate load test, Block vibration test	2
1.8	Correlations of dynamic soil properties with SPT N value.	1
2		
2.1	**Analysis of Machine Foundations**: Modes of vibrations of a rigid foundation block	1
2.2	Linear Elastic Weightless Spring method of analysis for all modes of vibration	2
2.3	Numerical problems	3
2.4	Concept of elastic Half-space method of analysis.	3
3		
3.1	**Design of foundation for reciprocating machines** -Design of foundations for reciprocating machines (IS method of Design)	4
3.2	Design requirements	3
3.3	Design procedure for block type foundation-Necessary data, design criteria, permissible amplitude	4
4		
4.1	**Design of foundation for Impact type machines-**Design criteria and design procedure for block type foundation (IS method)	5
4.2	Properties and requirements of cushion pad	2
4.3	Construction criteria of foundations for impact type of machines.	2

5		
5.1	**Vibration isolation for Machine Foundations**: Choice of vibration isolation	1
5.2	IS Guidelines	1
5.3	Active and passive isolation, Transmissibility, Design of wave barriers (open trench)	2
5.4	Dynamic properties of vibration isolators- coil springs, rubber springs, cork pads	1
5.5	Design procedure for foundations on absorbers	2

CET499	ENVIRONMENTAL POLLUTION CONTROL TECHNIQUES	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		VAC	3	1	0	4	2019

Preamble: The course is designed to impart knowledge on the fundamental aspects of environmental pollution and its control techniques among students. It helps the learners to understand the sources of environmental pollution, characteristics of pollutants, waste treatment techniques and empower the learners to adopt appropriate strategies to control the environmental pollution.

Pre-requisite: Nil

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

CO1	Explain the basic concepts of Air pollution and Water pollution
CO2	List the environmental protection laws and acts implemented in India to abate the Environmental Pollution
CO3	Describe various treatment techniques used to control the Environmental Pollution
CO4	Differentiate the treatment techniques for domestic sewage and industrial wastewater
CO5	Explain the different practices adopted for solid waste management of a community

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					2	2					
CO2	3					2	1					
CO3	3					3	2					
CO4	3					2	2					
CO5	3					3	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	:	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 students should answer anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Qn. No	Question	Marks	Course outcome (CO) Assessed
	Part A(Answer all questions)		
1	What are the different sources of air pollutants?	3	CO1
2	What are the various approaches to minimize exhaust emissions from automobiles?	3	CO1
3	Write a short note on skimming tanks.	3	CO3
4	Give a general layout of a waste treatment plant.	3	CO3

5	Explain the biological characteristics of Industrial wastes.	3	CO4
6	Explain the significance of pre-treatment of industrial waste and briefly describe any one method.	3	CO4
7	What are the drawbacks of incineration?	3	CO5
8	What are the different waste minimization strategies?	3	CO5
9	Enumerate the different environmental rules and regulations in India.	3	CO2
10	What are the different methods for the identification of environmental impacts of a project?	3	CO2
	Part B **(Answer ANY ONE FULL question from each module)**		
Module I			
11	What do you mean by particulate pollutants? Explain the various means to control them.	14	CO1
12	Explain in detail, the different means to control gaseous pollutants	14	CO1
Module II			
13	Explain with a neat sketch, the working of an activated sludge process. State the merits and demerits of the process as well.	14	CO3
14	Explain with a neat sketch, the working of a trickling filter. Also state its merits and demerits.	14	CO3
Module III			
15	Explain High Rate Anaerobic Treatment method for treating industrial wastes.	14	CO4
16	Explain equalization and proportioning for treating industrial wastes.	14	CO4
Module IV			

17	How do the waste matters are stabilized during Sanitary Land Filling? Explain.	14	CO5
18	What is composting? Explain various types of composting.	14	CO5
Module V			
19	Explain Environmental Management Plan.	14	CO2
20	Discuss the different Environmental protection laws and acts in India with respect to Air Pollution.	14	CO2

Syllabus

Module 1 (9hrs)

Introduction to environmental pollution-Air pollution – Sources – Primary pollutants, Secondary pollutants - Criteria pollutants – Effects - Control of gaseous pollutants (adsorption, absorption, reaction and other methods) – Control of particulate pollutants (settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators)– Automobile pollution control, Air Pollution Mitigation Measures - Ambient air quality standards.

Module 2 (9hrs)

Water pollution – Sources – Various Pollutants – Effects - Treatment and control methods – Physico-chemical and Biological Treatments – Screening, skimming, sedimentation, coagulation, Filtration, Trickling Filters, Activated sludge process, Oxidation ponds,

Module 3 (9hrs)

Industrial Pollution - Characteristics of industrial wastes: physical, chemical and biological. Pretreatment of industrial wastes: waste volume reduction, waste strength reduction neutralization, equalization and proportioning. High rate anaerobic methods (design not needed). Essential elements of an Environmental Management System (EMS)

Module 4 (9hrs)

Solid waste management: Type and source of solid waste, characteristics, collection, segregation, transportation and processing- Waste minimization strategies – Reduction - Recycling – Reuse; Disposal - composting, sanitary landfill, incineration; Hazardous Waste Treatment and Disposal - Biological and chemical treatment of hazardous wastes, Landfill disposal of hazardous waste; Bioremediation of hazardous waste disposal sites.

Module 5 (8hrs)

Administrative and Legislative control of environmental pollution. Important Environmental rules and regulations, environmental protection acts and rules. Environmental Management Plan, identification and mitigation of environmental impacts.

Text Books

1. Peavy, Rowe, Tchobanoglous, Environmental Engineering, Mc Graw Hill International Editions.

2. M.N. Rao & H.V.N. Rao, Air Pollution, Tata Mc Graw Hill Pvt. Ltd., New Delhi.

3. S. K. Garg, Environmental Engineering Vol. l & ll, Khanna Publishers, New Delhi.

4. B.C. Punmia, Waste water Engineering, Arihant Publications, Jodpur.

5. C.S. Rao, Environmental Pollution Control Engineering, New Age International (P)Ltd, New Delhi.

References

1. Nelson Leonard Nemerow, Theories and practices of industrial waste treatment, Addison-Wesley Publishing Co., Inc.

2. W Wesley Eckenfelder Jr., Industrial water pollution control, International Edition, Mc Graw Hill Inc, New Delhi.

3. M Narayana Rao, Waste water treatment, Rational methods of design and Industrial practice, Oxford & IBH Publishing Co. Pvt. Ltd, Bombay.

4. Warren Viessman and mark J Hammer, Water Supply and Pollution Control, Pearson Education, Inc.

5. Gilbert M.Masters, Kurian Joseph and R. Nagendran, Introduction to Environmental Engineering and Science.

6. Ruth F. Weiner and Robin Matthews, Environmental Engineering, Butterworth-Heinemann, Elsevier.

Course content and Schedule of Lecture

Module	Topic	Course outcome addressed	No of Hours
Module I (9 Hours)			
1.1	Introduction to environmental pollution	CO1	1
1.2	Air pollution – Sources – Primary pollutants, Secondary pollutants Criteria pollutants– Effects	CO1	2
1.3	Control of gaseous pollutants	CO1	2
1.4	Control of particulate pollutants	CO1	2
1.5	Automobile pollution control	CO1	1
1.6	Air Pollution Mitigation Measures- Ambient air quality standards.	CO1	1
Module II (9 Hours)			
2.1	Water pollution – Sources – Various Pollutants – Effects	CO3	1

2.2	Physico-chemical and Biological Treatments – Screening, Skimming	CO3	1
2.3	Sedimentation	CO3	1
2.4	Coagulation	CO3	1
2.5	Filtration	CO3	1
2.6	Trickling Filters	CO3	1
2.7	Activated sludge process	CO3	2
2.8	Oxidation ponds	CO3	1
Module III (9 Hours)			
3.1	Industrial Pollution - Characteristics of industrial wastes: physical, chemical and biological	CO4	2
3.2	Pretreatment of industrial wastes: waste volume reduction	CO4	2
3.3	Waste strength reduction neutralization	CO4	1
3.4	Equalization and proportioning, High rate anaerobic methods	CO4	2
3.5	Essential elements of an Environmental Management System (EMS)	CO4	2
Module IV (8 Hours)			
4.1	Solid waste management: Type and source of solid waste, characteristics	CO5	1
4.2	Collection, segregation, transportation and processing	CO5	1
4.3	Waste minimization strategies – Reduction - Recycling – Reuse	CO5	1
4.4	Disposal - composting, sanitary landfill, incineration	CO5	2
4.5	Hazardous Waste Treatment and Disposal	CO5	1
4.6	Biological and chemical treatment of hazardous wastes	CO5	1
4.7	Landfill disposal of hazardous waste	CO5	1
4.8	Bioremediation of hazardous waste disposal sites	CO5	1
Module V (8 Hours)			
5.1	Administrative and Legislative control of environmental pollution	CO2	2
5.2	Important Environmental rules and regulations	CO2	2

5.3	Environmental protection acts and rules	CO2	2
5.4	Environmental Management Plan, identification and mitigation of environmental impacts	CO2	2

Model Question Paper

Reg.No.:…….. **QP CODE:……..**

Name:……

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: CET 499
Environmental Pollution Control Techniques

Max. Marks: 100 **Duration: 3 hours**

Part A

(Answer all questions; each question carries 3 marks)

1. What are the different sources of air pollutants?
2. What are the various approaches to minimize exhaust emissions from automobiles?
3. Write a short note on skimming tanks.
4. Give a general layout of a waste treatment plant.
5. Explain the biological characteristics of Industrial wastes.
6. Explain the significance of pre-treatment of industrial waste and briefly describe any one method.
7. What are the drawbacks of incineration?
8. What are the different waste minimization strategies?
9. Enumerate the different environmental rules and regulations in India.Explain the significance of pre-treatment of industrial waste and briefly describe any one method.
10. What are the different methods for the identification of environmental impacts of a project?

Part B

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

MODULE 1

11. What do you mean by particulate pollutants? Explain the various means to control control them.

OR

12. Explain in detail, the different means to control gaseous pollutants.

MODULE 2

13. Explain with a neat sketch, the working of an activated sludge process. State the merits and demerits of the process as well.

OR

14. Explain with a neat sketch, the working of a trickling filter. Also state its merits and demerits.

MODULE 3

15. Explain High Rate Anaerobic Treatment method for treating industrial wastes.

OR

16. Explain Equalisation and Proportioning for treating industrial wastes.

MODULE 4

17. How do the waste matters are stabilized during Sanitary Land Filling? Explain.

OR

18. What is composting? Explain various types of composting.

MODULE 5

19. Explain Environmental Management Plan.

OR

20. Discuss the different Environmental protection laws and acts in India with respect to air pollution.

SEMESTER VIII

CET402	QUANTITY SURVEYING AND VALUATION	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	0	0	2	2019

Preamble: The course provides the knowledge about various types of estimation and specification of different civil engineering works. It equips students to analyze the rate of various items of work with reference to the standard data and schedule of rate. This course develops capability of students to prepare the detailed estimate of various items of work related to civil engineering construction and also preparation of the valuation of land and buildings.

Prerequisite: Building drawing

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	Define basic terms related to estimation, quantity surveying and contract document	Remembering
CO2	Interpret the item of work from drawings and explain its general specification and unit of measurement.	Understanding
CO3	Make use of given data from CPWD DAR/DSR for calculating the unit rate of different items of work associated with building construction	Applying
CO4	Develop detailed measurement (including BBS) and BoQ of a various work like buildings, earthwork for road, sanitary and water supply work	Applying
CO5	Explain various basic terms related to valuation of land and building	Understanding
CO6	Develop valuation of buildings using different methods of valuation.	Applying

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10		10
Understand	10	10	30
Apply	30	40	60
Analyse			
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 marks
Assignment/Quiz/Course project : 15marks

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

Part A contain 3 questions from Module-I & II. Answer any 2 question, each question caries 10 marks.

Part B contains 3 questions from Module III of which student should answer any 2 questions. Each full question carries 25 marks.

Part C contains 3 questions from Module IV of which student should answer any 2 questions. Each question carries 15 marks.

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.

Sample Course Level Assessment Questions

CO1: Define basic terms related to estimation, quantity surveying and contract document

1.	What is mean by the term (a) Work charge establishment (b) Provisional quantity
2.	List different type of estimate. Explain any two in detail.

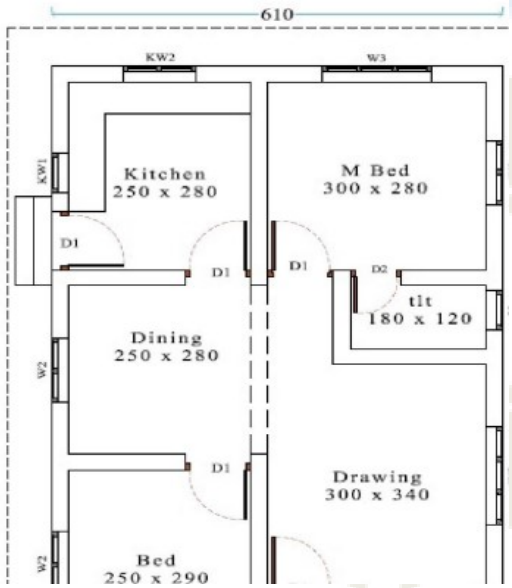
CO2: Interpret the item of work from drawings and explain its general specification and unit of measurement.

1	Give the units of following work (a) Carpentry fitting (b) Pointing (c) Plastering
2	Explain the general rule of measurement as per Indian Standards

CO3: Make use of given data from CPWD DAR/DSR for calculating the unit rate of different items of work associated with building construction

1.	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. **Material** : 20mm Aggregate 0.57m^3@₹1300/m^3, 10mm 0.28m^3@ ₹1300/m^3, coarse sand (Zone III) 0.425m^3@₹1200/m^3, Portland cement 400kg@₹5700/tonne. **Labour :** Mason 0.24@₹467/day, Beldar 2.75@₹368/day, Bhisti 0.90@₹407/day, Coolie 1.88@₹368/day **Carriage provisions** : Stone aggregate below 40mm 0.85m^3@₹103.77 , Portland cement 0.40tonne@₹5700/tonne. **Hire Charges** for concrete mixer 0.08@₹800/day, Vibrator needle type ₹0.08@350/day **Sundries** (LS) 14.30@₹1.73. Adopt water charges, contractor profit and overheads as per the CPWD DSR2018 provisions.

CO4: Develop detailed measurement (including BBS) and BoQ of a various work like buildings, earthwork for road, sanitary and water supply work

1.	List the any four items of work in plumbing work of residential building
2.	Write the unit of measurement of (i) Carpentry fittings (ii) Pointing of Brick Wall
3.	Prepare a bar bending schedule and quantities of RCC and reinforcement of a simply supported beam of length 6.5 m , depth 50 cm, and width 30 cm reinforced with 3 Nos of 20 mm dia at bottom as straight bar, 2 Nos of 20 mm dia cranked at 45o , 2 Nos 16 Φ at top of beam and 8 mm Φ 2 legged stirrups @ 15 cm c/c
4.	Prepare detailed measurement for the following items of work for the construction of residential building shown below using Centre line method (a) RRM for foundation (75cm x 75cm) and basement50cm x 50cm , Wall thickness 20cm (b) Brick work for superstructure (c) RCC works for slab (12cm thick), lintel (15cm thick), and sun shade (60cm projection) (d) Painting for walls, doors(D1-100x210; D2 80x210) and windows (W2-100x150; W3-150x150;KW1-50x100;KW2-100x100); V(90x60).  Also Calculate No. of brick, cement & sand required for Brick wall

CO5: Explain various basic terms related to valuation of land and building

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.
4	Differentiate the terms Value, Cost and Price

CO6: Develop valuation of buildings using different methods of valuation.

1.	A building is situated by the side of a main road of Mumbai city on a land of 500sq m. 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.	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.

Syllabus

MODULE 1.

Introduction- Quantity Surveying- Basic principles, Role/responsibility of Quantity surveyor at various stages of construction

Estimate-Details required, Type of estimate, purposes.

Contingencies, Work-charge establishment, Tools and Plant, centage charge, Day work, Prime cost, Provisional sum & provisional Quantity, Overhead charges, Cost index, Contract documents (Brief description only)

Bill of Quantity -Typical format-use

Item of works- Identify various item of work from the drawings-units of measurement of various materials and works (focus may give to RCC residential building)

General rule & method of measurement with reference to Indian Standard Specifications-IS1200.

MODULE 2.

Introduction to the use of CPWD schedule of rates as per latest DSR and Analysis of rate as per latest DAR

Specifications-General specification of all items of a residential building.

Detailed specification (CPWD specifications) of major item of work like Earth work excavation in foundation, masonry, Reinforced cement concrete, finishing of building work

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 (Data should be given).

MODULE 3.

Detailed Estimate- Preparation of detailed measurement using Centre line method & Short wall long wall (separate wall) method for RCC single storied building (Flat roof) including stair cabin- Residential/office/school building.

BOQ preparation of a single storied RCC building work.

Material quantity calculation of the items of work (Rubble, Brick work, Concrete work, Plastering) in detailed estimate prepared for building work. (Data for unit quantity should be provided from DAR)

Bar Bending Schedule- Preparation of BBS of RCC beams, slabs, Column footings, Retaining wall.

Road estimation-Estimation of earthwork from longitudinal section-metaled road.

Estimation of sanitary and water supply work -Water tank, Septic tank, Manhole *(No Detailed estimate needed-concept of item of work, its general specification and unit of measurement*).

MODULE 4.

Valuation – purpose, factor affecting, introduction to terms-Value, Cost, Price, kinds of values Income- Gross income, net income, outgoings, annuity, sinking fund, Year's purchase, Depreciation, obsolescence -Free hold and leasehold properties.

Methods of calculating depreciation – straight line method – constant percentage method, sinking fund method and quantity survey method.

Methods of valuation– rental method, direct comparison of capital cost, valuation based on profit, depreciation method.

Various method of valuation of land (Brief description only)

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 Chakraborthy, 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
5. CPWD Specifications Vol1 & 2 (2019 or latest edition)

Course Contents and Lecture Schedule

Module	Topic	Course Outcomes addressed	No. of Lectures
1	**Module I: Total lecture hours:8**		
1.1	Introduction to Quantity survey, basic principle, Role/responsibility of Quantity surveyor, Estimate-List the types, Details required	CO1	1
1.2	Types of estimates, simple problems of approximate estimate, purpose	CO1	1
1.3	Contingencies, Work-charge establishment, Tools and Plant, centage charge, Day work, Prime cost, Provisional sum & provisional Quantity (Brief description only)	CO1	1
1.4	Bill of Quantity -Typical format-use	CO2	1

1.5	Units of measurement of various materials and works	CO2	2
1.6	General rule & method of measurement with reference to Indian Standard Specifications-IS1200	CO2	1
1.7	Introduction to the use of CPWD schedule of rates as per latest DSR and Analysis of rate as per latest DAR, Overhead charges, Cost index.	CO2	1
2	**Module II: Total lecture hours-5**		
2.1	Specifications-General specification of various items of building work.	CO3	1
2.2	Detailed specification of major item of work like Earth work excavation in foundation, masonry, Reinforced cement concrete, finishing of building work with reference to CPWD specifications	CO3	2
2.3	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 (All data (Material, labour & machine) and rate will be given in the question paper)	CO3	2
3	**Module III: Total lecture hours: 16**		
3.1	Preparation of detailed measurement and abstract of estimate using Centre line method & Short wall long wall (separate wall) method- Explain with a single room building example	CO4	2
3.2	Preparation of detailed measurement for RCC single storey buildings with stair cabin- Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, flooring, Woodwork, Staircase.	CO4	5
3.3	Preparation of BoQ of single storied RCC building	CO4	1
3.4	Material quantity calculation of the Rubble, Brick work, Concrete work, plastering in detailed	CO4	1

	estimate of RCC building (Data for unit quantity should be provided from DAR)		
3.5	BBS of RCC beams, slabs, Column footings, Retaining wall	CO4	4
3.6	Road estimation-Estimation of earthwork from longitudinal section-metaled road	CO4	2
3.7	Estimation of sanitary and water supply work - Water tank, Septic tank , Manhole (Concept only)	CO4	1
4	**Module IV: Total lecture hours: 7**		
4.1	Valuation –Purpose, factor affecting- Introduction to terms-Value, Cost, Price, Income- Gross income, net income, outgoings, annuity, sinking fund (Simple Examples), Year's purchase, Depreciation, obsolescence -Free hold and leasehold properties.	CO5	2
4.2	Depreciation – methods of calculating depreciation – straight line method, constant percentage method, sinking fund method, and quantity survey method-numerical examples	C06	2
4.4	Methods of valuation of land with building – rental method, direct comparison of capital cost, valuation based on profit, depreciation method.	CO6	2
4.5	Various method of valuation of land (Brief description only)	CO6	1

Model Question Paper

Reg.No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: CET402

Course Name: QUANTITY SURVEYING AND VALUATION

Max.Marks:100 Duration: 3Hours

General Instructions: 1. Supplement answers with illustrations, wherever necessary.

2. Assume any missing data and state the assumptions clearly. Assumptions should be realistic.

PART A

Answer Two full question

(10×2 marks = 20 marks)

Module 1 & II

1. a. Explain the terms (a) Cost index (b) Overhead charges (4)
   b. List different type of Estimate. Explain the detailed estimate (6)
2. a. What are different types of specification? (2)
   b. Reproduce the detailed specification for earthwork excavation for foundation (8)
3. Develop unit rate of the work (DSR 2018 item No. 4.1.2), providing and laying in position 1:1½:3 (1 Cement: 1½ coarse sand (zone-III) : 3 graded stone aggregate 20 mm nominal size) cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : MATERIAL : 0.57cu.m 20mm nominal size of stone aggregate @ Rs.1370/cu.m., 0.28cu.m 10mm nominal size of stone aggregate @ Rs.1350/cu.m., 0.425 cu.m of coarse sand (Zone-III) @Rs.1350/cu.m., 0.2833cu.m Portland cement @ Rs.4940/tonne, LABOUR : 0.10 Mason @ Rs.709/day; 1.63 Beldar @ Rs.558/day, 0.70 Bhisti @ Rs.617/day. CARRIAGE PROVISIONS: Stone aggregate below 40mm Rs. 103.77/cu.m.; coarse sand @Rs.103.77/cu.m. and for cement @ Rs.92.24/tonne. HIRE CHARGES of concrete mixer 0.07@Rs.800/day, Vibrator 0.07@Rs.370/day, SUNDRIES , LS, 14.30@Rs.2 (10)

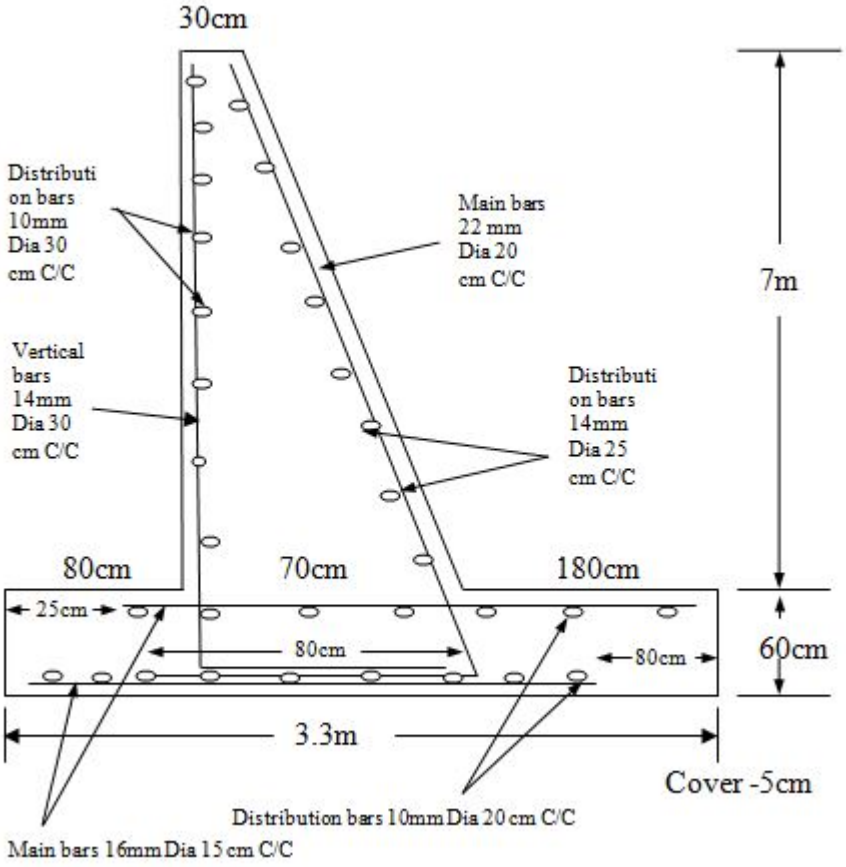
PART B

Answer Two full question

(2 x 25=50 Marks)

Module III

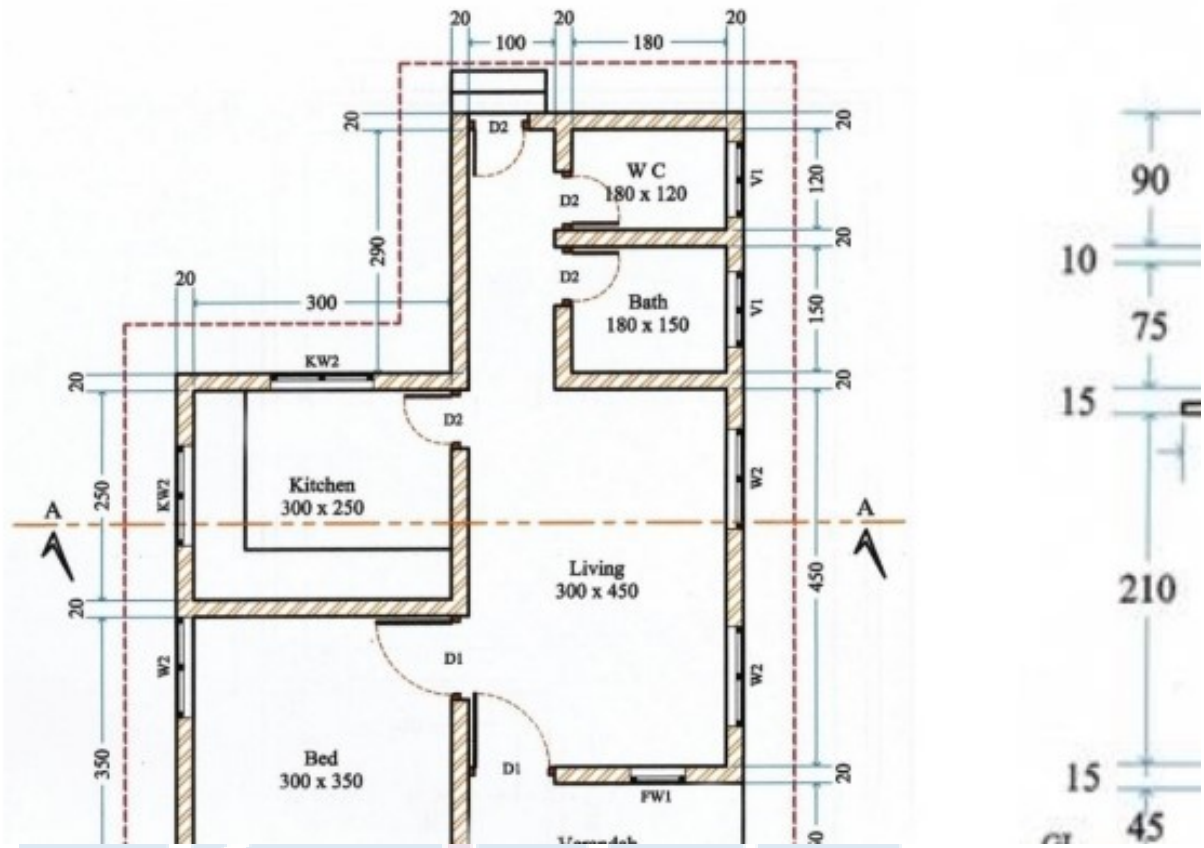
4. Prepare Schedule of bars and calculate the quantities of material required for constructing a retaining wall shown in figure. Length of retaining wall 20m.



5. Calculate the following quantity of the given plan using Centre line method. Assume suitable dimensions for Doors & Windows

(Door D1 -100x210; D2 -80x210; W2 -120x140; V1- 90x60; KW2- 120x90; FW1- 60x180)

(a) Earth work excavation, Width of base Concrete 75cm
(b) Foundation (60cm x 60cm) and basement (45cm x 45cm) with RR masonry
(c) Brick work for super structures, CM1:6
(d) RCC 1:2:4 for roof
(e) Wood work for door and windows



6. **a.** A simply supported beam of size 450 x 230 having a span of 6m is supported on a 30cm wall at both ends. The stirrups of 10mm diameter are provided at a spacing of 150mm c/c. The beam have main bar of 3 no's 20mm diameter at bottom including one bend up bar and stirrup holders are of 2 no's 16mm diameter at top. Main & Stirrup holder reinforcement is provided with a cover of 25mm. Calculate the total quantity of the reinforcement required for the stirrup for this beam. Also prepare an estimate of tor steel reinforcement for stirrup including cutting, bending , placing in position and binding, adopt the rate as Rs.95/kg. (10 Marks)

b. Calculate the quantity of earth work for a portion of road of length 700m. Formation width of road is 8m, side slope in banking 2: 1 and 1:1 in cutting, road has a down gradient of 1 in 150, formation level 160 at distance 0.

Distance (m)	0	100	200	300	400	500	6
Reduced	158.9	159.10	159.20	162.20	160.80	160.70	1

(15 Marks)

PART C

Answer Two full question

(2 x 15=30 Marks)

7. **a.** A concrete mixer was purchased at Rs.8000/-. Assuming salvage value to be Rs.1000, after5years, 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 Rs.12,000/- per annum for the next -60years. 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%? (7 marks)

8. **a.** Explain various method of land valuation (8 marks)

   b. 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. (8 marks)

9. a. List the factors affecting valuation. (5 marks)

   b. Explain the significance of sinking fund, How it is calculated. (5 marks)

   c. A person purchased a property for Rs.50,00,000/-. Assuming its salvage value after 40 years will be Rs. 5,00,000/-, determine amount of depreciation each year considering it to be uniform. (5 marks)

CET404	COMPREHENSIVE COURSE VIVA	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : 25 Marks

CED416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	0	0	12	4

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

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

Abstract POs defined by National Board of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

Phase 2 Targets

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.
- Preparing a report in the standard format for being evaluated by the Department Assessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	**5**	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the work done so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	**5**	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	**5**	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end of phase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. ·[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 2 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

SEMESTER VIII

PROGRAM ELECTIVE III

CET414	ADVANCED STRUCTURAL DESIGN	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	3	0	0	3	2019

Preamble: This course intends to brush-up the fundamentals of design of reinforced concrete and steel structures by limit state design and review the usage of relevant codes. The course offers to make students competent by covering contemporary engineering practices in the structural design. This course is also intended to develop the mixed qualities to students in structural engineering point of view - independently handling the design problems and to work in a group for team works (through assignments)

Prerequisite: CET303 Design of Concrete Structures, CET401 Design of Steel Structures

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	Design and detail cantilever retaining wall and understand the design principles of Counter fort retaining wall. And Design and detail deep beams	Applying Understanding
CO2	Design and detail water tanks as per IS code provisions	Applying
CO3	Explain Concept of yield line theory and design of different slab using yield line theory Design of Flat slabs using IS code provisions.	Understanding Applying
CO4	Analyse and design Cold form light gauge section.	Applying
CO5	Use of latest industry standard formula, table, design aids used for design of beams and portal frames under pattern loading.	Understanding Applying

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	25	25	50
Analyse	5	5	10
Evaluate	5	5	10
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: Design and detail cantilever retaining wall and understand the design principles of Counter fort retaining wall. And Design and detail deep beams

1. Identify the situations in which each type of retaining wall is used.
2. Design a cantilever retaining wall has to retain earth 3.5 m high above ground level. The density of earth is 17 KN/m^3 and its angle of repose is 300. The earth is horizontal at top. The safe bearing capacity of soil is 180 KN/m^2 and coefficient of friction between soil and concrete is 0.55

CED496	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	4

Preamble: Mini Project Phase I: A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Chemical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of three/four students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

- Survey and study of published literature on the assigned topic;
- Preparing an Action Plan for conducting the investigation, including team work;
- Working out a preliminary Approach to the Problem relating to the assigned topic;
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
- Preparing a Written Report on the Study conducted for presentation to the Department;

CO1	Identify and synthesize problems and propose solutions to them.
CO2	Prepare work plan and liaison with the team in completing as per schedule.
CO3	Validate the above solutions by theoretical calculations and through experimental
CO4	Write technical reports and develop proper communication skills.
CO5	Present the data and defend ideas.

Mapping of course outcomes with program outcomes

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

*1-slight/low mapping, 2- moderate/medium mapping, 3-substantial/high mapping

Continuous Internal Evaluation Pattern:

Sl. No.	Level of Evaluation	Marks
1	Interim evaluation by the committee	**20**
2	Project Guide	**30**
3	Final Seminar evaluation by the committee	**30**
4	The report evaluated by the evaluation committee	**20**
	Total	**100**
	Minimum required to pass	**50**

The evaluation committee comprises a panel of HoD or a senior faculty member, Project coordinator and project supervisor.