CET302	STRUCTURAL ANALYSIS - II	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	3	1	0	4	2019

Preamble: The course enables the students to analyse various types of multistoreyed structures using appropriate methods and tools. It utilises the procedures of force methods and displacement methods for analysing framed structures. Plastic theory and its applications are introduced to students. A very important topic of applications of principles of dynamics to analyse structures while undergoing dynamic deformations is also made familiar with. The course trains the students to develop mathematical models and helps to sharpen their analytical skills, which also helps the student to lay foundation for further advanced topics like finite element method.

Prerequisite: CET301Structural Analysis I

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 principles of plastic theory and its applications in structural analysis.	Understanding, Applying
CO2	Examine the type of structure and decide on the method of analysis.	Analysing, Applying
CO3	Apply approximate methods of analysis for framed structures to ascertain stress resultants approximately but quickly.	Analysing, Applying
CO4	Apply the force method to analyse framed structures.	Understanding,Analysing, Applying
CO5	Apply the displacement methods to analyse framed structures.	Understanding, Analysing, Applying
CO6	Remember basic dynamics, understand the basic principles of structural dynamics and apply the same to simple structures.	Remembering, 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	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	3	1	-	-	-	-	-	-	-	-	-
CO4	3	3	1	-	-	-	-	-	-	-	-	-
CO5	3	3	1	-	-	-	-	-	-	-	-	-
CO6	3	3	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	50
Analyse	15	15	20
Evaluate			
Create			

Mark distribution

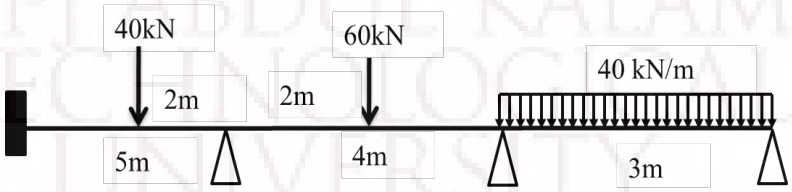
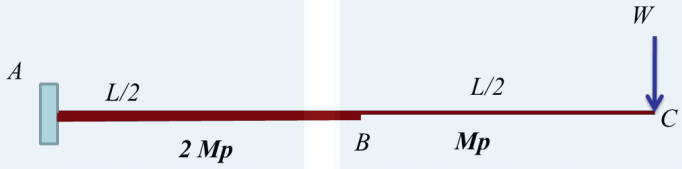
Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

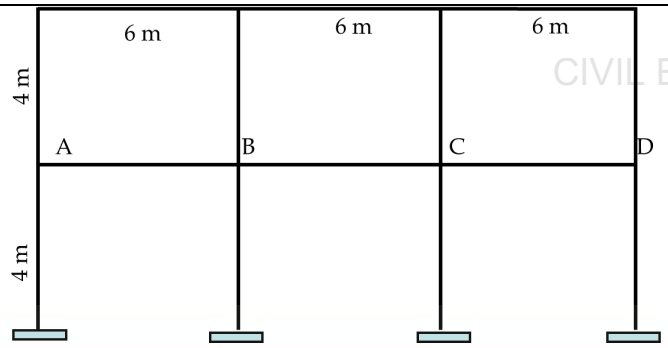
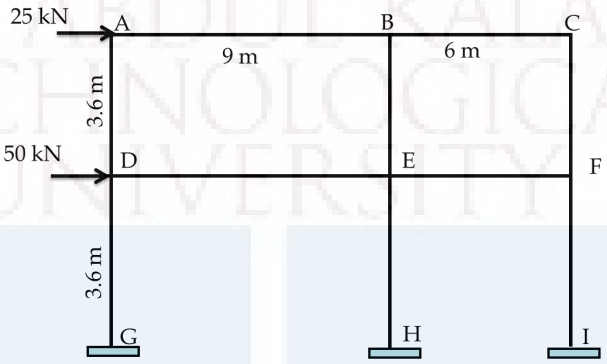
End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each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

Course Level Assessment Questions

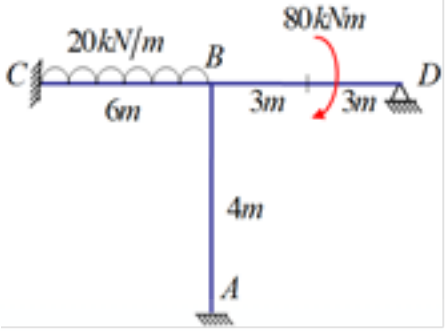
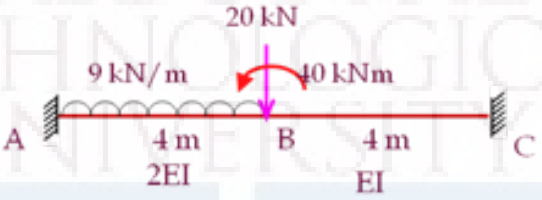
CO1:	**Understand the principles of plastic theory and its applications in structural analysis.**
1.	Derive an expression for the shape factor of a rectangular cross section.
2.	Explain the terms 'design plastic moment capacity of a member' and 'collapse load of a structure'
3.	Find the plastic moment capacity of the beam shown in figure. Assume uniform section throughout. 
4.	For the cantilever in Fig.2, determine the collapse load. 

CO2:	**Examine the type of structure and decide on the method of analysis.**
1.	Differentiate between force and displacement methods of analysis of framed structures.
2.	Explain how you will determine the suitability of force method or displacement method for analysis of a structure?
3.	Which are the situations in which an analyst uses approximate methods of structural analysis? What are their advantages and disadvantages?

CO3:	**Apply approximate methods of analysis for framed structures to ascertain stress resultants approximately but quickly.**
1.	What are the assumptions in cantilever method?
2.	Total dead load is 12 kN/m and total live load is 20 kN/m on ABCD. Analyse the frame for midspan positive moment on BC, using substitute frame method.

	
3.	Analyse the frame in figure using portal method. 

CO4:	**Apply the force method or displacement method to analyse structures accurately.**
1.	Derive stiffness matrix for the degrees of freedom shown for the beam in figure. 
2.	Prove that flexibility matrix is the inverse of stiffness matrix for a given set of actions and corresponding displacements.
3.	Analyse the beam in figure using flexibility method. 
4.	Determine all the member end moments for the frame shown in figure, using stiffness method.

	
5.	Determine the displacements at B for the beam shown in figure, using stiffness method. 
6.	Find all the joint displacements for the beam in Figure 5, using direct stiffness method. 

CO5:	**Remember basic dynamics, understand the basic principles of structural dynamics and apply the same to simple structures.**
1.	Explain the components of the basic dynamic system
2.	Derive an expression for the free-vibration response of a damped SDOF system.
3.	Explain transient and steady-state responses
4.	A vibrating system consists of a weight of W = 100kN and a spring with stiffness k = 20 N/m is viscously damped so that the ratio of two consecutive amplitudes is 1/0.85. Detemine: a) the natural frequency of the undamped system, b) the damping ratio, c) the damping coefficient and d) the damped natural frequency.

SYLLABUS

MODULE I – 9 hrs.

Plastic Theory: Introduction – plastic hinge concepts – plastic modulus – shape factor – redistribution of moments – collapse mechanisms – Plastic analysis of beams and portal frames by equilibrium and mechanism methods.(single storey and single bay frames only) – 6 hrs.

Approximate methods of analysis of multistoried frames:

Analysis for vertical loads-substitute frames-loading condition for maximum hogging and sagging moments in beams and maximum bending moment in columns – 3 hrs.

MODULE II – 9 hrs.

Approximate methods (continued): Wind load analysis of multistoried frames – portal method and cantilever method for lateral load analysis. – 2 hrs.

Matrix analysis of structures:

Definition of flexibility and stiffness influence coefficients - Concepts of physical approach – 1 hr.

Flexibility method: flexibility matrices for truss and frame elements-load transformation matrix-development of total flexibility matrix of the structure-analysis of simple structures-plane truss and plane frame-nodal loads and element loads-lack of fit and temperature effects. – 6 hrs.

MODULE III – 9 hrs.

Stiffness method: Development of stiffness matrices by physical approach-stiffness matrices for truss and frame elements-displacement transformation matrix-analysis of simple structures-plane truss and plane frame-nodal loads and element loads-lack of fit and temperature effects. – 9 hrs.

MODULE IV – 9 hrs.

Direct stiffness method: Introduction to direct stiffness method-Rotation of axes in two dimensions, stiffness matrix of elements in global co- ordinates from element co-ordinates-assembly of load vector and stiffness matrix, solution of two span continuous beam-single bay single storey portal frame. – 9 hrs.

MODULE V

Structural dynamics:

Introduction - degrees of freedom - equation of motion, D'Alembert's principle-damping-free response of damped and undamped systems- logarithmic decrement-- single degree of freedom systems subjected to harmonic load - transient and steady state responses, simple portal frame problems. – 9 hrs.

Text Books:

1. James M Gere & William Weaver, Matrix Analysis of Framed Structures - (CBS Publishers)
2. Mechanics of Structures Vol I & II, Junnarkar S.B., Charotar Publishing House
3. Devdas Menon, Structural Analysis, Narosa Publications
4. Wang C.K., Intermediate Structural Analysis, McGraw Hill
5. Mario Paz, Structural Dynamics

References:

1. Pandit and Gupta, Structural Analysis – A Matrix Approach
2. Reddy C. S., Basic Structural Analysis, Tata McGraw Hill
3. Norris and Wilbur, Elementary Structural Analysis, Tata McGraw Hill
4. Punmia B. C., Strength of Materials and Mechanics of Structures, Laxmi Publications
5. RC Hibbeler, Structural Analysis
6. Wang C K, Matrix Method of Structural Analysis
7. Anil. K. Chopra, Dynamics of structures, Pearson Education/ Prentice Hall India,
8. Clough R.W. and Penzein, J., Dynamics of structures - Tata McGraw Hill
9. Madhujith Mukhopadhyay and Abdul Hamid Sheikh, Matrix and Finite Element Analysis of Structures, Ane Books India.
10. Rajasekharan&Sankara Subramanian, Computational Structural Mechanics
11. William T Thomson, Theory of vibration with application
12. Tse, Morse Hinkle, Mechanical Vibrations

Lecture Plan –Structural Analysis II

Module	Topic	Course Outcomes addressed	No. of Lectures
1	**Module I: Total lecture hours: 9**		
1.1	Plastic Theory: Introduction – concept of plastic hinge	CO1	1
1.2	Plastic modulus – shape factor	CO1	1
1.3	Redistribution of moments – collapse mechanisms – plastic analysis of beams and portal frames by equilibrium and mechanism methods(single storey and single bay frames only)	CO1	4
1.4	Introduction to approximate methods of analysis of multistoried frames, analysis for vertical loads-substitute frames	CO2, CO3	1
1.5	Loading condition for maximum hogging and sagging moments in beams and maximum bending moment in columns – numerical problems	CO3	2
2	**Module II: Total lecture hours: 9**		
2.1	Approximate methods (continued): Wind load analysis of multistoried frames – portal method and cantilever method for lateral load analysis.	CO3	2
2.2	Introduction to matrix analysis of structures: Definition of flexibility and stiffness influence coefficients - Concepts of physical approach	CO2, CO4	1
2.3	Flexibility method: flexibility matrices for truss and frame elements	CO4	1
2.3	Load transformation matrix-development of total flexibility matrix of the structure	CO4	1
2.4	Analysis of simple structures-plane truss and plane frame-nodal loads and element loads	CO4	3
2.5	Lack of fit and temperature effects		1
3	**Module III: Total lecture hours: 9**		
3.1	Stiffness method: Development of stiffness matrices by physical approach	CO5	1
3.2	Stiffness matrices for truss and frame elements-displacement transformation matrix	CO5	2

3.3	Analysis of simple structures-plane truss and plane frame-nodal loads and element loads	CO5	5
3.4	Lack of fit and temperature effects	CO5	1
4	**Module IV: Total lecture hours: 9**		
4.1	Direct stiffness method: Introduction to direct stiffness method-global co-ordinates andlocal co-ordinates.	CO2, CO5	1
4.2	Rotation of axes in two dimensions, stiffness matrix of elements in global co- ordinates from element co-ordinates- assembly of load vector and stiffness matrix	CO5	2
4.3	Solution of numerical problems on two span continuous beam – single bay single storey portal frame	CO5	6
5	**Module V: Total lecture hours: 9**		
5.1	Structural dynamics: Introduction - degrees of freedom - equation of motion, D'Alembert's principle - Damping	CO6	2
5.2	Free response of damped and undamped systems	CO6	2
5.3	Logarithmic decrement	CO6	1
5.4	Single degree of freedom systemssubjected to harmonic load - transient and steady state responses	CO6	2
5.5	Simple portal frame problems	CO6	2

MODEL QUESTION PAPER

Reg.No.:_____		Name:_____

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

Course Code: CET302

Course Name: STRUCTURAL ANALYSIS II

Max. Marks: 100		Duration: 3 Hours

PART A

Answer all questions; each question carries 3 marks.

1.	a)	Derive an expression for the shape factor of a rectangular cross section.
	b)	What are the advantages and disadvantages of approximate methods of structural analysis?
	c)	Derive flexibility matrix for the co-ordinates shown for the beam in figure. 
	d)	What are the assumptions in cantilever method?
	e)	Derive stiffness matrix for the degrees of freedom shown for the beam in figure. 
	f)	Prove that flexibility matrix is the inverse of stiffness matrix for a given set of actions and corresponding displacements.
	g)	Explain local co-ordinates and global co-ordinates.
	h)	Write down the steps involved in direct stiffness method.
	i)	Explain the components of the basic dynamic system.
	j)	Explain transient and steady-state responses.

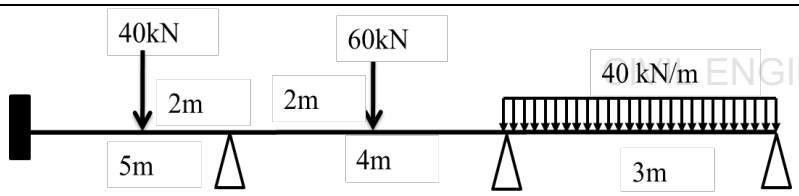
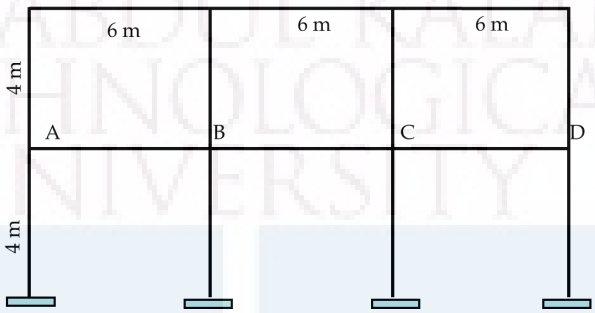
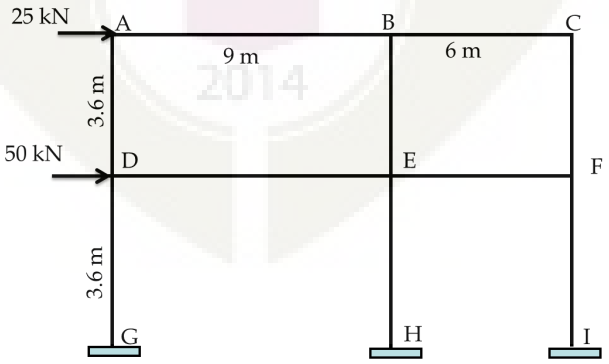
(10×3 marks = 30 marks)

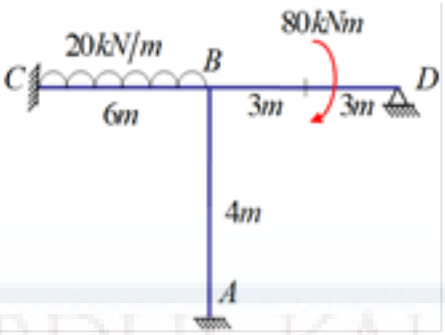
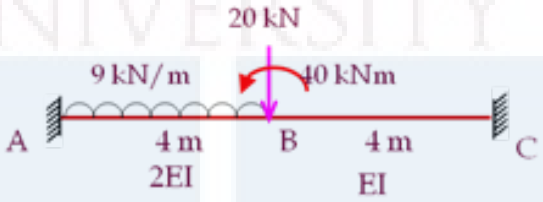
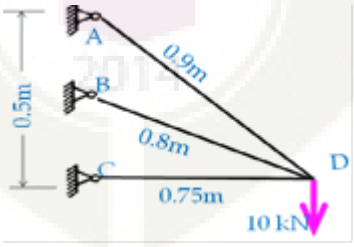
PART B

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

Module I

2.		Find the plastic moment capacity of the beam shown in figure. Assume uniform section throughout .

	 (14 marks)
3.	Total dead load is 12 kN/m and total live load is 20 kN/m on ABCD. Analyse the frame for midspan positive moment on BC, using substitute frame method.  (14 marks)
	Module II
4.	Analyse the beam in figure using flexibility method.  (14 marks)
5	Analyse the frame in figure using portal method. 
	Module III

6.	Determine all the member end moments for the frame shown in figure, using stiffness method.  (14 marks)
7.	Determine the displacements at B for the beam shown in figure, using stiffness method.  (14 marks)
	Module IV
8.	Find all the joint displacements for the beam in Figure 5, using direct stiffness method.  (14 marks)
9.	Find the joint displacements for the pin-jointed truss shown in figure, using direct stiffness method.  (14 marks)
	Module V

10.	Derive an expression for the free-vibration response of a damped SDOF system (Underdamped case only). (14 marks)
11.	A vibrating system consists of a weight of W = 100kN and a spring with stiffness k = 20 N/m is viscously damped so that the ratio of two consecutive amplitudes is 1/0.85. Detemine: a) the natural frequency of the undamped system, b) the damping ratio, c) the damping coefficient and d) the damped natural frequency (14 marks)
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CET308	COMPREHENSIVE COURSE WORK	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	1	0	0	1	2019

Preamble: The course is designed to ensure that the student have firmly grasped the foundational knowledge in Civil Engineering familiar enough with the technological concepts. It provides an opportunity for the students to demonstrate their knowledge in various Civil Engineering subjects.

Pre-requisite: Nil

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

CO1	Learn to prepare for a competitive examination
CO2	Comprehend the questions in Civil Engineering field and answer them with confidence
CO3	Communicate effectively with faculty in scholarly environments
CO4	Analyze the comprehensive knowledge gained in basic courses in the field of Civil Engineering

CET 308 Comprehensive Course Work		PO	PO	PO	PO	PO	PO	PO	PO	PO	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
	CO1	3	1	1			2							1	1	
	CO2	3	1				2				3					
	CO3	3	1			1	2				3				1	
	CO4	3	3			1	2									

Assessment pattern

Bloom's Category	End Semester Examination (Marks)
Remember	25
Understand	15
Apply	5
Analyze	5
Evaluate	
Create	

End Semester Examination Pattern:

A written examination will be conducted by the University at the end of the sixth semester.The written examination will be of objective type similar to the GATE examination.Syllabus for the comprehensive examination is based on following five Civil Engineering core courses.

CET 201- Mechanics of Solids

CET 203- Fluid Mechanics and Hydraulics

CET 205- Surveying& Geomatics

CET 204- Geotechnical Engineering I

CET 309–Construction Technology and Management

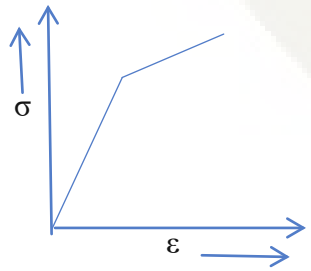
The written test will be of 50 marks with 50 multiple choice questions (10 questions from each module) with 4 choices of 1 mark each covering all the five core courses. There will be no negative marking. The pass minimum for this course is 25. The course should be mapped with a faculty and classes shall be arranged for practising questions based on the core courses listed above.

Written examination	:	50marks
Total	**:**	**50 marks**

Course Level Assessment and Sample Questions:

1) Poisson's ratio for an incompressible isotropic material is:
   A) 0.25 B) 0.5 C) Zero D) Indeterminate

2) The following stress-strain curve is obtained for a material. It indicates



A) Rigid body behaviour
B) Perfectly plastic behaviour

C) Elastic-linear strain hardening behaviour
D) Elastic- plastic behaviour

3) A principal plane is one where the shear stress will be:
A) Maximum B) Minimum C) Zero D) Coverage of principal stress

4) In a differential manometer, the flowing fluid is water and the gauge fluid is mercury. If the manometer reading is 100mm, the differential head in meters is:
A) 13.6 B) 1.36 C)1.47 D)1.26

5) A rectangular open channel carries a flow of $2m^3$/sec/m, what is the value of minimum specific energy?
A) 0.74m B) 1.11m C) 1.48m D) 1.85m

6) A pipe has diameter 0.4m, length 0.1km and coefficient of friction 0.005. What is the length of an equivalent pipe which has diameter 0.2m and coefficient of friction 0.008?
A) 195m B) 19.5m C)1.95m D) 1950m

7) The true bearing of a line is 40°30'. Declination is 3°W. The magnetic bearing of line is:
A) 43°30' B) 37°30' C) 36°30' D) 44°30'

8) Points C and D are 1530m apart across a wide river. The following reciprocal levels are taken with one level.

Level at	Reading on	
	C	D
C	3.810 m	2.165 m
D	2.355 m	0.910 m

The true difference in elevation between C and D is:

A)1.645 m B) 1.545 m C) 1.745 m D) 1.345 m

9) Fore bearing of a line is 540°. Declination is 2°W. True bearing of line is:
A)222° B) 218° C) S 42°E D) S 38° E

10) The dry density of a soil is 1.5 g/cc. If the saturation water content were 50%, then its saturated density and submersed density would respectively be,
A)1.5 g/cc and 1.0g/cc B)2.0 g/cc and 1.0 g/cc C)2.25 g/cc and 0.25 g/cc
D)2.50 g/cc and 1.50 g/cc

11) A clay sample has a void ratio of 0.50 in dry state and if the specific gravity of solids is 2.70, its shrinkage limit will be
A)12% B)13.5% C)18.5% D)22%

12) A non–homogenous soil deposit consists of a silt layer sandwiched between a fine–sand layer at top and a clay layer below. Permeability of the silt layer is 10 times the permeability of the clay layer and one–tenth of the permeability of the sand layer. Thickness of the silt layer is 2 times the thickness of the sand layer and two–third of the thickness of the clay layer. The ratio of equivalent horizontal and equivalent vertical permeability of the deposit is _____.
A)10.967 B)10.968 C)10.969 D)None of these

13) Which cement contains high percentage of C_3S and less percentage of C_2S?
A) Rapid Hardening Cement B) Ordinary Portland Cement C) Quick Setting Cement D) Low Heat Cement

14) Workability of concrete is measured by _____
A) Vicat apparatus test B) Slump test C) Minimum void method D) Talbot Richard test

15) The shortest possible time in which an activity can be achieved under ideal circumstances is known as _____
A) Pessimistic time estimate B) Optimistic time estimate C) Expected time estimate D) None of these

Course Code: CET 308

Comprehensive Course Work

MODULE 1

Concept of stress and strain, Hooke's law, Stress-strain diagram of mild steel;Axially loaded bars.Temperature stress in composite bars, Poisson's ratio, Elastic constants and the relationship between them.Beams, Concept of bending moment and shear force, Shear force and bending moment diagrams of cantilever beams, simply supported beams and overhanging beams for different type of loads. Theory of simple bending; Shear stress in beams. Principal stresses and principal planes in 2D problems, maximum shear stress; Mohr's circle .

MODULE 2

Fluid properties; Fluid statics, measurement of fluid pressure. Buoyancy and Floatation: Buoyant force, Principle of floatation, stability of floating andsubmerged bodies, metacentre and metacentric height; continuity equation in one, two and three dimensions.Bernoulli's equation and its applications; Pipe flow- computation of major and minor losses in pipes,equivalent pipe.

Open channel flow, velocity distribution in open channels, uniform flow computations, Most economical sections, Specific energy, Critical flow; Hydraulic jump.

MODULE 3

Introduction to Surveying- Principles, Linear, angular and graphical methods.Bearing of survey lines, Local attraction, Declination; Principles of levelling, Methods of levelling. Theodolite surveying, Measurement of horizontal and vertical angle; Triangulation. Traverse Surveying, Checks in closed traverse; Theory of Errors – Types, theory of least squares, Weighting of observations. Total Station – concept of EDM, principles and working. GPS-Components and principles. Remote Sensing.

MODULE 4

Definitions and properties of soil, 3 phase system, Index properties of soil, Soil classification, Effective stress, Quick sand condition, Stress distribution, Permeability of soil, Darcy's law, Factors affecting permeability, Laboratory tests, Consolidation, Normally consolidated, over consolidated and under consolidated soils, Time factor, Coefficient of consolidation, Compaction Tests – OMC and MDD, shear strength of soil, Triaxial compression test, Unconfined compression test, Direct shear test and Vane shear test

MODULE 5

Cement: Manufacturing, chemical composition, Types, Tests, Hydration of cement. Properties of fresh concrete and hardened concrete. Types of stone masonry – composite walls - cavity walls and partition walls - Construction details and features. Finishing works: Plastering, Pointing, Painting – objectives and types. Prefabricated construction – advantages and disadvantages, Prefabricated building components. Causes of failures in RCC and Steel structures. Types of tenders, Types of contracts. Types of Schedules. Network analysis –CPM, PERT – concepts and problems

CET306	DESIGN OF HYDRAULIC STRUCTURES	Category	L	T	P	Credit	Year of Introduction
		PCC	4	0	0	4	2019

Preamble: The general objective of this course is to expose the students to the fundamental concepts of hydraulic design of different hydraulic structures and to develop the drawings of minor irrigation structures. This course equip the students to perform the hydraulic design of minor irrigation structures such as cross drainage works, canal falls and regulators and prepare drawings of the same. To impart the knowledge on causes of failure and design criteria of hydraulic structures like dams and canal structures.

Pre-requisite: Fluid Mechanics and Hydraulics, Hydrology & Water Resources Engineering

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

CO1	Elucidate the causes of failure, principles of design of different components of hydraulic structures
CO2	Describe the features of canal structures and perform the design of alluvial canals
CO3	Perform the hydraulic design of minor irrigation structures such as cross drainage works, canal falls, cross regulator
CO4	Prepare the scaled drawings of different minor irrigation structures
CO5	Describe the design principles and features of dams and perform the stability analysis of gravity dams

CO - PO Mapping

1 – Slight (Low), 2 – Moderate (Medium), 3 – Substantial (High)

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

Assessment pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	5	5	10
Understand	10	10	20
Apply	20	20	40
Analyze	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
(For the first internal test, minimum two design should be included)		
Assignment/Quiz/Course project	:	15 marks
Assignment should be scaled drawings (in A_2 size sheet)		
Total	**:**	**50 marks**

End semester examination pattern: There will be three parts; Part A, Part B and Part C. Part A contains 2 questions each from Modules I and II, out of which student can answer any one. Total marks for this part will be 30. Each question can have maximum 2 sub-divisions and carry 15 marks. Part B will be for 50 marks with 25 mark for design and 25 mark for drawing (not to scale) based on Module III. In the drawing part, two views should be asked. Part C will be for 20 Marks. Two full questions each from Modules IV and V carrying 10 mark should be asked and the student can answer any one from each module. The examination will be for 3 hours.

Course Code: CET306
Design of Hydraulic Structures
Course Level Assessment Questions

CO1	**Elucidate the causes of failure, principles of design of different components of hydraulic structures**
1	State Khosla's interim conclusions
2	Explain the causes of failure of weirs on permeable soils and state the remedial measures
3	Explain the corrections to be applied on % uplift pressure estimated by the method of independent variables
4.	Obtain the expression for floor thickness as per Bligh's theory

CO2	**Describe the features of canal structures and perform the design of alluvial canals**
1	State the functions of under sluices and divide walls
2	Explain the classification of cross drainage structures
3	Describe the features of a Siphon well drop with a sketch
4.	Explain Kennedy's theory for the design of Alluvial channels
5.	Explain (i) level crossing (ii) canal siphon with sketches
6.	Design an irrigation canal through alluvial soils for the following data : Discharge =20 m^3/sec; Lacey's silt factor =1

CO3	**Perform the hydraulic design of minor irrigation structures such as cross drainage works, canal falls, cross regulator.**
1 (a) (b)	**Design a 1.5 m Sarda Type Fall for a canal carrying a discharge of 40 cumecs with the following data** Bed Level Upstream-105.0m Bed Level Downstream-103.5m Side Slopes of canal-1:1 Full Supply Level Upstream-106.8 m Bank level upstream-107.4 m Bed width-U/s and D/s-30 m Safe Exit Gradient for Khosla's theory-1/5 Sketch following views of the structure: (a) Half plan at top level and half at foundation level (b) Longitudinal sectional elevation
CO4	**Prepare the scaled drawings of different minor irrigation structures**

1. (a)	Design a 1.8 m trapezoidal notch fall for the following data (Assignment): Details above drop: Full supply discharge= 5.5 cumec Bed width= 5 m Bed level= 19.8 Full supply depth=1.6 m Level at the top of the bank=22.4 The bank top width is 1.8 m Details below drop: Full supply discharge= 5.5 cumec Bed width= 5 m Full supply level=19.6 Level at the top of the bank=20.6 The bank top width is 1.8 m
(b)	Develop following drawings to a suitable scale: (a) Half sectional plan at foundation level (b) Section along the centre line of the canal

CO5	**Describe the design principles and features of dams and perform the stability analysis of gravity dams**
1	Explain the features of different types of spillways
2	State the functions of Galleries and Keys in gravity dam
3	Obtain the expression for base width of elementary profile of gravity dams for no tension criteria
4	Differentiate low dams and high dams
5.	Explain the causes of failure of earth dams
6.	Enlist the design criteria of earth dams
7.	State the limitations of thin cylinder theory

Course Code: CET 306
Design of Hydraulic Structures
Syllabus

Module I

Diversion headwork-components and functions; Weirs – types and causes of failure- Impervious floor of hydraulic structures –Bligh's theory, Design of vertical drop weir; Design of impervious floor of hydraulic structures by Khosla's theory

Module II

Canals-types, Cross section of unlined canals and alignment; Design of canals through alluvial soils- Kennedy's theory and Lacey's silt theory. Canal structures- cross drainage structures-types; Canal falls-Necessity, types

Module III

Hydraulic design and drawing of canal structures
(i) Aqueduct; (ii) Siphon Aqueduct; (iii) Canal drop (Trapezoidal Notch Fall); (iv) Sarda type fall (trapezoidal crest- impervious floor design using Khosla's theory); and (v) Cross regulator (impervious floor design using Khosla's theory)

Module IV

Dams-types; Gravity Dams-computation of forces-modes of failure and stability criteria, stability analysis. Elementary and practical profile, limiting height of gravity dams, Galleries, joints, keys, water stops, instrumentation, grouting (brief description only)

Module V

Earth dams-types, causes of failure and design criteria, Arch dams- thin cylinder theory; Spillways-types-Ogee spillway profile; Energy dissipation- stilling basins-Indian standard Type I and Type II (description only)

Text Books:

- Sathyanarayana M. C. Water Resources Engineering-Principles and Practice, New Age International Publishers. 2009
- Garg S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, New Delhi 2006.
- KR Arora. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors, New Delhi. 2010.

References:

- Punmia B.C.Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering. Laxmi Publications (P) Ltd 2009.
- Modi P.N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors, New Delhi 2009.
- Varshney, R.S. Theory & Design of Irrigation Structures -Vol III, Nem Chand & Bros., Roorkee.

Course Code: CET 306
Design of Hydraulic Structures
Course Plan

Module	Topic	Course outcome addressed	No of Hours
Module I (8 Hours)			
1.1	Introduction on different types of Irrigation structures	CO2	1
1.2	Layout of diversion headwork- components and functions	CO2	1
1.3	Causes of failure of weirs on permeable soils and remedies	CO1	1
1.4	Bligh's theory, problem	CO1	1
1.5	Design of vertical drop weir	CO1	1
1.6	Khosla's theory-Interim conclusions and Khosla's first problem	CO1	1
1.7, 1.8	Khosla's method of independent variables- use of charts and corrections	CO1	2
Module II (8 Hours)			
2.1	Types of canals, alignment of canals	CO2	1
2.2	Typical cross sections of unlined canals	CO2	1
2.3	Design of channels through alluvial soils- Kennedy's theory	CO2	1
2.4, 2.5	Lacey's silt theory- problems	CO2	2
2.6	Classification of cross drainage structures	CO2	1
2.7, 2.8	Canal falls – necessity and types	CO1	2
Module III (15 Hours)			
3.1-3.3	Hydraulic design of Aqueduct and demonstration of drawing	CO3, CO4	3
3.4-3.6	Hydraulic design of Siphon Aqueduct and demonstration of drawing	CO3, CO4	3
3.7-3.9	Hydraulic design of Canal drop (Trapezoidal Notch Fall) and demonstration of drawing	CO3, CO4	3

3.10-3.12	Hydraulic design of Sarda Fall with trapezoidal crest and demonstration of drawing	CO3, CO4	3
3.13-3.15	Hydraulic design of Cross regulator and demonstration of drawing	CO3, CO4	3
Module IV (7 Hours)			
4.1	Dams-Types, Computation of Forces acting on dams	CO5	1
4.2	Stability analysis- modes of failure and stability criteria of gravity dams	CO5, CO1	1
4.3	Stresses-No tension criteria, derivation of principal stress	CO5, CO1	1
4.4	Problems on stability analysis of gravity dams	CO5, CO1	1
4.5	Elementary and practical profile of gravity dams	CO5, CO1	1
4.6	Functions and types of galleries, keys and water stops etc in dams	CO5	1
4.7	Instrumentation and grouting of dams	CO5	1
Module V (7 Hours)			
5.1	Arch dams- types, thin cylinder theory	CO5, CO1	1
5.2	Most economical central angle of arch dam, Limitations of thin cylinder theory	CO5, CO1	1
5.3. 5.4	Earth dams, types, causes of failure and design criteria	CO5, CO1	2
5.5	Spillways- Types	CO5	1
5.6	Ogee spillway profile	CO5, CO1	1
5.7	Energy dissipation below spillways-stilling basins	CO5, CO1	1

Model Question Paper

Reg No.:…….. QP CODE: ……..

Name:……

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

Course Code: CET 306
Course Name: DESIGN OF HYDRAULIC STRUCTURES

Max. Marks: 100 Duration: 3 hours

- *Use of Khosla's Chart, Blench Curves and Montague Curves are permitted in the Examination Hall*
- *Assume suitable design data wherever necessary*

PART A

(Answer one full question from each module, each question carries 15 marks)

Module I

1	**a.**	State the functions of under sluices and divide walls.	(6 marks)
	b.	Explain Khosla's corrections.	(9 marks)

OR

2	**a.**	State and explain Bligh's theory.	(5 marks)
	b.	Explain the causes of failure of weirs on permeable soils and state the remedial measures.	(10 marks)

Module II

3	**a.**	Explain the factors to be considered in the alignment of canals.	(5 marks)
	b.	Explain the classification of cross drainage structures.	(10 marks)

OR

4	**a.**	Compare Kennedy's theory and Lacey's theory.	(6 marks)
	b.	Design an irrigation canal through alluvial soils for the following data: Discharge =20 m^3/sec; Lacey's silt factor =1	(9 marks)

PART B
(Answer any ONE full question)

Module III

5 **a.** Design a suitable cross drainage work for the following data: (25 marks)

Canal:

Full supply discharge	= 30 *cumec*
Bed level	= +250.00 *m*
Depth of water	= 1.50 *m*
Bed width	= 20 *m*
Side slope	= 1.5 **H : 1V**
Manning *N* for concrete	= 0.016

Drainage:

High flood discharge	= 250 *cumec*
High flood level	= +247.50 *m*
High flood depth	= 2.50 *m*
General ground level	= +251.00 *m*
Silt factor	= 1.0

b. Develop the following drawings:

i. Half sectional plan at foundation level and at top (15 marks)

ii. Longitudinal section along the centre line of the canal (10 marks)

OR

6 **a.** Design a 2 m trapezoidal notch fall for the following data: (25 marks)

Details above drop:

Full supply discharge	= 5.5 *cumec*
Bed width= 6 *m* Bed level	= 12.000
Full supply depth	=1.5 m
Level at the top of the bank	=14.5

Bank top width is 3 m

Details below drop:

Full supply discharge	= 5.5 cumec
Bed width	= 6 m
Full supply level	=11.5
Level at the top of the bank	=12.5

Bank top width is 3 m

b. Develop the following drawings:

i. Half sectional plan at foundation level and at top (15 marks)

ii. Section along the centre line of the canal (10 marks)

PART C

(Answer one full question from each module, each question carries 10 marks)

Module IV

7 **a.** Obtain an expression for principal stress at the toe of a gravity dam. (4 marks)

b. Explain elementary profile of gravity dam. How you will develop the practical profile from it? (6 marks)

OR

8 **a.** Differentiate consolidation grouting and curtain grouting. (4 marks)

b. Determine the uplift force at the base of gravity dam of base width 25 m, height of water in the u/s face = 30 m, free board 3m, top width 6 m and height of water in the d/s face = 5 m. The drainage gallery is at a distance of 5 m from the u/s end. (6 marks)

Module V

9 **a.** State the limitations of thin cylinder theory. (4 marks)

b. Explain the classification of earth dams with sketches. (6 marks)

OR

10 **a.** Explain the design features of Ogee spillway. (4 marks)

b. Explain the hydraulic and structural causes of failure of earth dams. (6 marks)

CET 304	ENVIRONMENTAL ENGINEERING	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	4	0	0	4	2019

Preamble This course introduces students to various treatment technologies for drinking water and domestic waste water. Students will learn the role of an environmental engineer in ensuring public health. They will understand how engineering approach can enhance the environmental quality by scaling up the physical and biological purification processes that exist in nature.

Prerequisite: CET 203 Fluid Mechanics and Hydraulics, CET 307 Hydrology &Water Resources Engineering

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 role of environmental engineering in improving the quality of environment	Understanding
CO2	To plan for collection and conveyance of water and waste water	Applying
CO3	To enhance natural water purification processes in an engineered environment	Analysing
CO4	To decide on appropriate technology for water and waste water treatment	Evaluating

Mapping of course outcomes with program outcomes (Minimum requirement)

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

CO1:To be able to appreciate the role of environmental engineering in improving the quality of environment

1.Explain from a health perspective the need for treating drinking water and safe disposal of waste water

2.How to dispose the sludge from waste water treatment plant safely?

3.How to remove colloidal range particles from water to satisfy drinking water norms?

CO 2: To be able to plan for collection and conveyance of water and waste water

1.How design period is decided for water supply schemes?

2.Discuss various types of pumps used in a water supply scheme

3.Compare separate and combined sewerage systems

CO3: To be able to enhance natural water purification processes in an engineered environment

1.Discuss different types of aerators with their advantage and limitations

2.Design a continuous flow rectangular sedimentation tank for a population of 20,000 persons with an average per capita demand of 120 litres per day. Assume a detention period of 6 hours.

3.Design an activated sludge plantto treat 6.0 Mld of sewage with BOD of 210 mg/l. The final effluent should be 30 mg/l

CO4: To be able to decide on appropriate technology for water and waste water treatment

1. Compare aerobic and anaerobic biological processes for treating waste water

2.Explain in detail the different disinfection techniques available for water and waste water treatment?

3.Discuss the treatment method available for high strength waste water

SYLLABUS

Module 1

Introduction to environmental engineering and role of environmental engineers-enhancing natural purification processes in an engineered environment-public health perspective for treating water and waste water - 1hr

Water quantity estimation:
Population forecast- water demand estimation-types of demand- demand fluctuation -3 hrs

Estimation for waste water quantity:
Dry weather flow and storm water flow-population equivalent-design period - 2 hrs
Collection and conveyance:
water intake structures- -gravity flow and pressure flow systems- 1 hr

Systems of sewerage: separate and combined-types of pumps for water and waste water conveyance - 2 hrs

Module 2

Layout plan of a conventional water treatment plant- site selection-concept of unit operations and unit processes-Screening-types of screens -aeration -aerator types- 3 hrs

Theory and principles of sedimentation-Stoke's law-Types of settling -Design of plain sedimentation tanks - 4 hrs

Mechanisms of coagulation and flocculation, popular coagulants and feeding devices -2 hrs

Module 3

Filtration of water-theory of filtration-types of filters - design of arapid sand filter - 3hrs

Disinfection of water - various methods - advantages and limitations -2 hrs

Lay out of water distribution network-types-methods of distribution-network analysis -Hardy cross and equivalent pipe methods-4 hrs

Module 4

Layout plan of a conventional waste water treatment plant- site selection- concept of primary, secondary and tertiary treatment- 1hr

Unit operations in waste water- primary treatment -equalization of flow- 2hrs

Secondary treatment methods-basic concepts of biological unit processes-aerobic and anaerobic- attached and suspended growth processes (Concepts only)- 2 hr

Activated sludge process- basic concepts-design of a conventional Activated Sludge Plant - 3hrs

Trickling filter (Concept only)- types- construction & operation - 1 hr

Module 5

Anaerobic treatment of high strength waste water- Up flow Anaerobic Sludge Blanket (UASB) reactor (Concept only)- 2 hrs

Natural waste water treatment systems-Oxidation Ponds and Lagoons-Wetlands and Root-zone systems (Concepts only)- 3 hrs

Low cost sanitation systems- Design of a septic tank and soak-pit - 2 hr

Sludge treatment (concepts only) -thickening- digestion- dewatering- drying- composting- 2hrs

Text Books:

1. Howard S Peavy, Donald R Rowe and George Tchobanoglous, Environmental Engineering, Mc Graw Hill Education , 2013
2. Mackenzie L Davis, David A Cornwell, Introduction to Environmental Engineering, Mc Graw Hill Education, 2014
3. S.K.Garg, Water Supply Engineering, Khanna Publishers. 2010
4. G S Birdie, Water Supply and Engineering, Dhanapat Rai Publishing Company, 2014
5. J. Arceivala, Shyam R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, McGrawhill Education, 2007
6. S.K. Garg, Sewage disposal and air pollution engineering, Khanna Publishers. 2008

References:

1. Metcalf and Eddy, Waste Water Engineering, Tata McGraw Hill publishing Co Ltd, 2003
2. Syed R Qasim, Edward M Motley, Guang Zhu, Water Works Engineering-Planning, Design & Operation, PHI Learning, 2012.
3. Syed R Qasim, Wastewater Treatment Plants-Planning, Design & Operation, CRC Press,1999

Lecture Plan- Environmental Engineering

Module	Topic	Course Outcomes addressed	No. of Lectures
1	**Module 1: Total Lecture Hours -9**		
1.1	Introduction to environmental engineering and role of environmental engineers-enhancing natural purification processes in an engineered environment-public health perspective for treating water and waste water	CO1	1
1.2	Water and waste water quantity estimation: Population forecast- water demand estimation-types of demand- demand fluctuation	CO2	3
1.3	Estimation for waste water quantity- dry weather flow and storm water flow-population equivalent-design period	CO2	2
1.4	Collection and conveyance: water intake structures- -gravity flow and pressure flow systems-	CO2	1
1.5	Systems of sewerage: separate and combined-types of pumps for water and waste water conveyance	CO2	2
2	**Module II: Total Lecture Hours- 9**		
2.1	Layout plan of a conventional water treatment plant- site selection-concept of unit operations and unit processes-Screening-types of screens-aeration-aerator types	CO1,CO4	3
2.2	Theory and principles of sedimentation-Stoke's law-Types of settling -Design of plain sedimentation tanks	CO3	4
2.3	Mechanisms of coagulation and flocculation, popular coagulants and feeding devices	CO3	2
3	**Module III: Total Lecture Hours-9**		
3.1	Filtration of water-theory of filtration-types of filters - design of rapid sand filter	CO3,CO4	3
3.2	Disinfection of water - various methods - advantages and limitations	CO4	2
3.3	Lay out of water distribution network-methods of distribution-network analysis -Hardy cross and equivalent pipe methods	CO4	4
4	**Module IV: Total Lecture Hours- 9**		

4.1	Layout plan of a conventional waste water treatment plant- site selection- concept of primary, secondary and tertiary treatment	CO1	1
4.2	Unit operations in waste water- primary treatment - equalization of flow	CO3	2
4.3	Secondary treatment methods- basic concepts of biological unit processes-aerobic and anaerobic- attached and suspended growth processes (Concepts only)	CO4	2
4.4	Activated sludge process- basic concepts-design of a conventional Activated Sludge Plant	CO3	3
4.5	Trickling filter (Concept only)- types- construction & operation	CO3	1
5	**Module V: Total Lecture Hours- 9**		
5.1	Anaerobic treatment of high strength waste water- Up flow Anaerobic Sludge Blanket (UASB) reactor (Concept only)	CO3	2
5.2	Natural waste water treatment systems-Oxidation Ponds and Lagoons-Wetlands and Root-zone systems (Concepts only)	CO3, CO4	3
5.3	Low cost sanitation systems- Design of a septic tank and soak-pit	CO3	2
5.4	Sludge treatment (concepts only) - thickening- digestion- dewatering- drying- composting	CO4	2

Model Question Paper

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

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

Course Code: CET304
Course Name: ENVIRONMENTAL ENGINEERING

Max. Marks: 100 Duration: 3 Hours

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

1. Explain dry weather flow
2. What is an intake?
3. Why screens are used in water and waste water treatment plants?
4. What is hindered settling?
5. Compare slow sand filter and rapid sand filter
6. Explain the principle of disinfection
7. Discuss the unit operations and unit processes in a waste water treatment plant
8. Compare aerobic and anaerobic processes
9. How wetlands treat waste water?
10. Explain the working of a septic tank with a neat sketch

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

11. (a) Explain in brief different methods used for prediction of future population of a city (9 Marks)

    (b) What is fire demand? How will you calculate fire demand (5 Marks)

OR

12. (a) Explain the term "Design Period" (5 Marks)

    (b) Forecast the population of the town in the year 2040 from the following data using arithmetic increase method and geometric increase method

Year	1990	2000	2010	2020
Population	13400	19500	28500	36300

(9 Marks)

13. (a) Explain with sketches the types of aerators with advantages and limitations (6 Marks)

(b) Explain different types of settling (8Marks)

OR

14. (a) Explain the mechanisms of coagulation (5 Marks)

(b) Design a plain sedimentation tank for treating 6 MLD of water. Make suitable assumption. Prepare a neat sketch (9 Marks)

15. (a) Explain the theory of filtration (5 Marks)

(b) Explain and compare various disinfection methods (9Marks)

OR

16. Design a rapid sand filter to treat 10 million litres of raw water per day allowing 0.5% of filtered water for backwashing. Half hour per day is used for backwashing. Assume necessary data. (14 Marks)

17. (a) Discuss the role of an equalization tank at a waste water treatment plant (4Marks)

(b) Discuss in detail various biological processes available for treating waste water . (10 marks)

OR

18. (a)Explain primary, secondary and tertiary treatment phases (5 Marks)

(b) Design an activated sludge plant treat 6.0 Mld of domestic sewage having a BOD of 210 mg/l. The final effluent should have a BOD of 30 mg/l. (9 Marks)

19. (a) Discusssludge treatment processes for safe disposal (9 Marks)

(b) Explain the working of a UASB with neat sketch (5 Marks)

OR

20. Discuss natural waste water treatment systems with neat sketches (14 Marks)

CET352	ADVANCED CONCRETE TECHNOLOGY	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PEC	3	0	0	3	2019

Preamble: This course is aimed at exposing the students to the fundamentals of properties of concrete materials, its testing procedures, various types of concretes, NDT of concrete and mix design. After this course, students will be in a position to determine the properties of concrete materials, testing of concrete and do a mix design based on requirement.

Prerequisite: CET309 CONSTRUCTION TECHNOLOGY& MANAGEMENT

Course Outcomes:

Course Outcome	Description of Course Outcome	Prescribed learning level
CO 1	To recall the properties and testing procedure of concrete materials as per IS code	Remembering, Understanding
CO 2	To describe the procedure of determining the properties of fresh and hardened concrete	Remembering, Understanding
CO 3	To design concrete mix using IS Code Methods.	Applying & Analysing
CO4	To explain nondestructive testing of concrete	Remembering, Understanding
CO5	To describe the various special types of concretes	Remembering, Understanding

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	-	-	-	2	2	3	-	-	-	-	-
CO 2	3	-	-	-	2	2	3	-	-	-	-	-
CO 3	3	3	3	2	2	2	3	-	-	-	-	-
CO4	3	-	-	-	2	2	3	-	-	-	-	-
CO5	3	-			3	2	3					

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	40
Understand	20	20	40
Apply	10	10	20
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 Questions

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

Course Outcome 1 (CO1): To recall the properties and testing procedure of concrete materials as per IS code

1. Discuss the hydration reaction of different cement compounds.
2. List the advantages and disadvantages of artificial aggregates.
3. Explain the classification of aggregates.
4. What are mineral admixtures? Explain GGBS and Flyash.

Course Outcome 2 (CO2): To describe the procedure of determining the properties of fresh and hardened concrete

1. What are the factors affecting strength and elasticity of concrete?
2. Define creep. What are the factors affecting creep.

3. Why is cube strength more than cylinder strength in concrete?

Course Outcome 3 (CO3): To design concrete mix using IS Code Methods.

1. List the methods available for proportioning concrete mix.
2. Design a concrete mix for any strength from the given data.
3. Write the properties of normal distribution curve. What are its uses in quality control'?

Course Outcome 4 (CO4): To explain nondestructive testing of concrete

1. State advanced non-destructive testing methods. Explain ány one in details.
2. Explain Schmidt's rebound hammer test to assess the strength of concrete.

Course Outcome 5 (CO5): To describe the various special types of concretes

1. Write short notes on underwater concreting and mass concreting.
2. Explain step by step procedure to design the Self compacting concrete.
3. Explain basic concept of Fibre reinforced concrete. Give examples of fibres suitable to improve
   i) flexural strength
   ii) impact strength
   iii) shear strength
4. Explain green concrete. State the various materials used in green concrete.

Syllabus

Module 1 Concrete materials

Cement -Review of manufacturing process- chemical composition, Bogue's compounds, mechanism of hydration-heat of hydration-**Aggregate**-Review of types, sampling and testing, artificial aggregates - **Chemical Admixtures**- types, uses, mechanism of action - effects on properties of concrete - **Mineral admixtures**- types, chemical composition - physical characteristics - effects on properties of concrete - **Rheology** – basic concepts – Bingham model

Module 2 Mix proportioning

Mix design - nominal mix- design mix – concept of mix design - variables of proportioning - general considerations - factors considered in the design of concrete mix- various methods of mix design - design of concrete mix as per IS 10262-2019 - **Statistical quality control of concrete** – mean strength – standard deviation – coefficient of variation – sampling - testing - acceptance criteria

Module 3 Properties of fresh and hardened Concrete

Properties of fresh concrete- workability-factors affecting workability - slump test- compaction factor test- Vee Bee consistometer test- **Properties of hardened concrete** - modulus of elasticity, compressive strength, split tensile strength, flexural strength- effect of water cement ratio – maturity concept- **Creep** - factors affecting creep - effect of creep- **Shrinkage**- factors affecting shrinkage - plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage.

Module 4 Durability & NDT of concrete

Durability of concrete- Factors affecting durability - permeability- cracking-reinforcement corrosion; carbonation, chloride penetration, sulphate attack, acid attack, fire resistance; frost damage, alkali silica reaction, concrete in sea water - **Non-destructive testing of concrete**- surface hardness test- ultrasonic pulse velocity method - penetration resistance- pull-out test- core cutting - measuring reinforcement cover.

Module 5 Special Topics in Concrete Technology

Special concretes - lightweight concrete-heavy weight concrete - high strength concrete – high performance concrete - self compacting concrete -roller compacted concrete– fibre reinforced concrete - polymer concrete-pumped concrete - ready mix concrete - green concrete. **Special processes and technology** - sprayed concrete; underwater concrete, mass concrete; slip form construction, prefabrication technology- 3D concrete printing

Text Books:

1. Neville A.M., "Properties of Concrete", Trans-Atlantic Publications, Inc.; 5e, 2016
2. R. Santhakumar „ Concrete Technology", Oxford Universities Press, 2018
3. Shetty M. S., Concrete Technology", S. Chand & Co., 2018

Reference Books

4. Mehta and Monteiro, Concrete-Micro structure, Properties and Materials", McGraw HillProfessional 2017
5. Neville A. M. and Brooks J. J., Concrete Technology, Pearson Education, 2019
6. Lea, Chemistry of Cement and Concrete", Butterworth-Heinemann Ltd, 5e, 2017

Lecture Plan – Advanced Concrete Technology.

Module	Topic	Course outcomes addressed	No. of Lectures
1	**Module I : Concrete materials Total lecture hours:7**		
1.1	Cement -Review of manufacturing process- chemical composition,	CO1	1
1.2	Bogue's compounds, mechanism of hydration-heat of hydration	CO1	1
1.3	Aggregate-Review of types, sampling and testing, artificial aggregates	CO1	1
1.4	Chemical Admixtures- types, uses, mechanism of action - effects on properties of concrete	CO1	1
1.5	- Mineral admixtures- types, chemical composition - physical characteristics - effects on properties of concrete	CO1	1
1.6	Rheology – basic concepts	CO2	1
1.7	Bingham model	CO2	1
2	**Module II: Mix proportioning Total lecture hours:7**		
2.1	Mix design - nominal mix- design mix – concept of mix design	CO3	1
2.2	Variables of proportioning - general considerations	CO3	1
2.3	Factors considered in the design of concrete mix- various methods of mix design	CO3	1
2.4	Design of concrete mix as per IS 10262-2019	CO3	2
2.6	Statistical quality control of concrete – mean strength – standard deviation	CO3	1
2.7	Coefficient of variation – sampling - testing - acceptance criteria	C03	1
	FIRST INTERNAL EXAMINATION		
	Module III : Properties of fresh and hardened Concrete Total lecture hours: 7		
3.1	Properties of fresh concrete- workability-factors affecting workability -	CO2	1
3.2	Slump test-compaction factor test- Vee Bee consistometer test	CO2	1
3.3	Properties of hardened concrete - modulus of elasticity, compressive strength	CO2	1

3.4	split tensile strength, flexural strength- effect of water cement ratio – maturity concept	CO2	1
3.5	Creep - factors affecting creep - effect of creep	CO2	1
3.6	Shrinkage- factors affecting shrinkage - plastic shrinkage, drying shrinkage	CO2	1
3.7	Autogenous shrinkage, carbonation shrinkage.	CO2	1
4	**Module IV: Durability & NDT of concrete Total lecture hours :7**		
4.1	Durability of concrete- Factors affecting durability	CO2	1
4.2	Permeability- cracking-reinforcement corrosion; carbonation,	CO2	1
4.3	Chloride penetration, sulphate attack, acid attack, fire resistance	CO2	1
4.4	Frost damage, alkali silica reaction, concrete in sea water	CO2	1
4.5	Non-destructive testing of concrete- surface hardness test	CO4	1
4.6	Ultrasonic pulse velocity method - penetration resistance	CO4	1
4.7	Pull-out test- core cutting - measuring reinforcement cover.	CO4	1
5	**Module V:Special Topics in Concrete Technology -Total lecture hours :7**		
5.1	Special concretes - lightweight concrete-heavy weight concrete	CO5	1
5.2	High strength concrete – high performance concrete -	CO5	1
5.3	self compacting concrete	CO5	1
5.4	Roller compacted concrete– fibre reinforced concrete - polymer concrete	CO5	1
5.5	Special processes and technology - sprayed concrete; underwater concrete	CO5	1
5.6	mass concrete; slip form construction	CO5	1
5.7	Prefabrication technology- 3D concrete printing	CO5	1

Model Question Paper
QP CODE:
Reg No.:_____ Name:_____

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

Course Code: CET352
Course Name: ADVANCED CONCRETE TECHNOLOGY

Max. Marks: 100 Duration: 3 hours

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

1. What are the properties of Bogue's compound?
2. What is the role of chemical admixtures in concrete?
3. Describe the factors considered in mixture proportioning.
4. Explain statistical quality control measures of concrete.
5. What is meant by shrinkage of concrete?
6. What are the factors affecting workability of concrete?
7. Describe the effect of fire on concrete.
8. Explain the pull-out test on concrete.
9. Write short notes on underwater concreting?
10. What are the applications of roller compacted concrete?

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

11. (a) . Explain concrete flow behaviour using a Bingham model. (6 Marks)

    (b). Describe the influence of mineral admixtures in concrete. Explain any two mineral admixtures in detail. (8 Marks)

OR

12. (a) Describe various tests for determining the quality of aggregate to be used for concreting work. (7 Marks)

    (b) Discuss the hydration reaction of different cement compounds. (7 Marks)

13. Design a concrete mix for the following data.
    Grade of concrete: M25, cement of 43 grade, moderate exposure, Zone III sand, compaction factor 0.9, 20mm maximum sized rounded aggregate. (14 marks)

OR

14. (a) Write down the procedure for concrete mix design by IS method. (8 Marks)
    (b) Explain different methods of mix design. (6 Marks)

15. (a) Explain the factors affecting the strength of concrete. (7 Marks)
    (b) Explain the procedure of determining flexural strength of concrete under four point bending (7 Marks)

OR

16. (a) Explain the procedure for determining modulus of elasticity of concrete. (7 Marks)
    (b) Explain the term creep, its effects and factors affecting creep. (7 marks)

17. (a) Explain the sulphate attack on concrete and explain the effect of sea water in concrete. (6 Marks)
    (b) Explain any two non-destructive tests in concrete. (8 marks)

OR

18. (a). Discuss the causes of corrosion of steel in concrete. (8 Marks)
    (b) What is meant by reinforcement cover? How is it measured? (6 Marks)

19. (a) Explain any two methods for testing fresh stage properties of self-compacting concrete. (8 Marks)
    (b) Explain green concrete. (6 Marks)

OR

20. (a) What is the influence of prefabrication technology on modern construction industry (8 Marks)
    (b) Describe sprayed concrete. (6 Marks)

HUT 300	Industrial Economics & Foreign Trade	Category	L	T	P	CREDIT
		HSMC	3	0	0	3

Preamble: To equip the students to take industrial decisions and to create awareness of economic environment.

Prerequisite: Nil

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

CO1	Explain the problem of scarcity of resources and consumer behaviour, and to evaluate the impact of government policies on the general economic welfare. (Cognitive knowledge level: **Understand**)
CO2	Take appropriate decisions regarding volume of output and to evaluate the social cost of production. (Cognitive knowledge level: **Apply**)
CO3	Determine the functional requirement of a firm under various competitive conditions. (Cognitive knowledge level: **Analyse**)
CO4	Examine the overall performance of the economy, and the regulation of economic fluctuations and its impact on various sections in the society. (Cognitive knowledge level: **Analyse**)
CO5	Determine the impact of changes in global economic policies on the business opportunities of a firm. (Cognitive knowledge level: **Analyse**)

Mapping of course outcomes with program outcomes

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

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	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

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	**15**	**15**	**30**

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
Continuous Assessment - Assignment	: 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B.

Part A	: 30 marks
Part B	: 70 marks

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 a student should answer any one. Each question can have maximum 3 sub-divisions and carries 14 marks.

SYLLABUS

HUT 300 Industrial Economics & Foreign Trade

Module 1 (Basic Concepts and Demand and Supply Analysis)

Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Module 2 (Production and cost)

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

Module 3 (Market Structure)

Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming.

Module 4 (Macroeconomic concepts)

Circular flow of economic activities – Stock and flow – Final goods and intermediate goods - Gross Domestic Product - National Income – Three sectors of an economy- Methods of measuring national income – Inflation- causes and effects – Measures to control inflation- Monetary and fiscal policies – Business financing- Bonds and shares -Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY.

Module 5 (International Trade)

Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments

deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers.

Reference Materials

1. Gregory N Mankiw, 'Principles of Micro Economics', Cengage Publications
2. Gregory N Mankiw, 'Principles of Macro Economics', Cengage Publications
3. Dwivedi D N, 'Macro Economics', Tata McGraw Hill, New Delhi.
4. Mithani D M, 'Managerial Economics', Himalaya Publishing House, Mumbai.
5. Francis Cherunilam, 'International Economics', McGraw Hill, New Delhi.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Why does the problem of choice arise?
2. What are the central problems?
3. How do we solve the basic economic problems?
4. What is the relation between price and demand?
5. Explain deadweight loss due to the imposition of a tax.

Course Outcome 2 (CO2):

1. What is shutdown point?
2. What do you mean by producer equilibrium?
3. Explain break-even point;
4. Suppose a chemical factory is functioning in a residential area. What are the external costs?

Course Outcome 3 (CO3):

1. Explain the equilibrium of a firm under monopolistic competition.
2. Why is a monopolist called price maker?
3. What are the methods of non-price competition under oligopoly?

4. What is collusive oligopoly?

Course Outcome 4 (CO4):

1. What is the significance of national income estimation?
2. How is GDP estimated?
3. What are the measures to control inflation?
4. How does inflation affect fixed income group and wage earners?

Course Outcome 5 (CO5):

1. What is devaluation?
2. Suppose a foreign country imposes a tariff on Indian goods. How does it affect India's exports?
3. What is free trade?
4. What are the arguments in favour of protection?

Model Question paper

QP CODE: **PAGES:3**

Reg No:_____ **Name :_____**

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

Course Code: HUT 300

Course Name: Industrial Economics & Foreign Trade

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Why does an economic problem arise?

2. What should be the percentage change in price of a product if the sale is to be increased by 50 percent and its price elasticity of demand is 2?

3. In the production function Q= $2L^{1/2}K^{1/2}$ if L=36 how many units of capital are needed to produce 60 units of output?

4. Suppose in the short run AVC 4. Suppose in the short run AVC<P<AC. Will this firm produce or shut down? Give reason.

5. What is predatory pricing?

6. What do you mean by non- price competition under oligopoly?

7. What are the important economic activities under primary sector?

8. Distinguish between a bond and share?

9. What are the major components of balance of payments?

10. What is devaluation? **(10 x 3 = 30 marks)**

PART B

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

MODULE I

11. a) Prepare a utility schedule showing units of consumption, total utility and marginal utility, and explain the law of diminishing marginal utility. Point out any three limitations of the law.

    b) How is elasticity of demand measured according to the percentage method? How is the measurement of elasticity of demand useful for the government?

Or

12. a) Explain the concepts consumer surplus and producer surplus.

    b) Suppose the government imposes a tax on a commodity where the tax burden met by the consumers. Draw a diagram and explain dead weight loss. Mark consumer surplus, producer surplus, tax revenue and dead weight loss in the diagram.

MODULE II

13. a) What are the advantages of large-scale production?

    b) Explain Producer equilibrium with the help of isoquants and isocost line. What is expansion path?

Or

14. a) Explain break-even analysis with the help of a diagram.

    b) Suppose the monthly fixed cost of a firm is Rs. 40000 and its monthly total variable cost is Rs. 60000.

    i. If the monthly sales is Rs. 120000 estimate contribution and break-even sales.
    ii. If the firm wants to get a monthly profit of Rs.40000, what should be the sales?

    c) The total cost function of a firm is given as $TC=100+50Q - 11Q^2+Q^3$. Find marginal cost when output equals 5 units.

MODULE III

15. a) What are the features of monopolistic competition?

b) Explain the equilibrium of a firm earning supernormal profit under monopolistic competition.

Or

16. a) Make comparison between perfect competition and monopoly.

b) Explain price rigidity under oligopoly with the help of a kinked demand curve.

MODULE IV

17. a) How is national income estimated under product method and expenditure method?

b) Estimate GDPmp, GNPmp and National income

Private consumption expenditure	= 2000 (in 000 cores)
Government Consumption	= 500
NFIA	= -(300)
Investment	= 800
Net=exports	=700
Depreciation	= 400
Net-indirect tax	= 300

Or

18. a) What are the monetary and fiscal policy measures to control inflation?

b) What is SENSEX?

MODULE V

19. a) What are the advantages of disadvantages of foreign trade?

b) Explain the comparative cost advantage.

Or

20. a) What are the arguments in favour protection?

b) Examine the tariff and non-tariff barriers to international trade.

(5 × 14 = 70 marks)

Teaching Plan

Module 1 (Basic concepts and Demand and Supply Analysis)		**7 Hours**
1.1	Scarcity and choice – Basic economic problems - PPC	1 Hour
1.2	Firms and its objectives – types of firms	1 Hour
1.3	Utility – Law of diminishing marginal utility – Demand – law of demand	1 Hour
1.4	Measurement of elasticity and its applications	1 Hour
1.5	Supply, law of supply and determinants of supply	1 Hour
1.6	Equilibrium – changes in demand and supply and its effects	1 Hour
1.7	Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	1 Hour
Module 2 (Production and cost)		**7 Hours**
2.1	Productions function – law of variable proportion	1 Hour
2.2	Economies of scale – internal and external economies	1 Hour
2.3	producers equilibrium – Expansion path	1 Hour
2.4	Technical progress and its implications – cob Douglas Production function	1 Hour
2.5	Cost concepts – social cost: private cost and external cost – Explicit and implicit cost – sunk cost	1 Hour
2.6	Short run cost curves & Long run cost curves	1 Hour
2.7	Revenue (concepts) – shutdown point – Break-even point.	1 Hour
Module 3 (Market Structure)		**6 hours**
3.1	Equilibrium of a firm, MC – MR approach and TC – TR approach	1 Hour
3.2	Perfect competition & Imperfect competition	1 Hour
3.3	Monopoly – Regulation of monopoly – Monopolistic competition	1 Hour
3.4	Oligopoly – kinked demand curve	1 Hour
3.5	Collusive oligopoly (meaning) – Non price competition	1 Hour
3.6	Cost plus pricing – Target return pricing – Penetration, Predatory pricing – Going rate pricing – price skimming	1 Hour

Module 4 (Macroeconomic concepts)		7 Hours
4.1	Circular flow of economic activities	1 Hour
4.2	Stock and flow – Final goods and intermediate goods – Gross Domestic Product - National income – Three sectors of an economy	1 Hour
4.3	Methods of measuring national income	1 Hour
4.4	Inflation – Demand pull and cost push – Causes and effects	1 Hour
4.5	Measures to control inflation – Monetary and fiscal policies	1 Hour
4.6	Business financing – Bonds and shares – Money market and capital market	1 Hour
4.7	Stock market – Demat account and Trading account – SENSEX and NIFTY	1 Hour
Module 5 (International Trade)		**8 Hours**
5.1	Advantages and disadvantages of international trade	1 Hour
5.2	Absolute and comparative advantage theory	2 Hour
5.3	Heckscher – Ohlin theory	1 Hour
5.4	Balance of payments - components	1 Hour
5.5	Balance of payments deficit and devaluation	1 Hour
5.6	Trade policy – Free trade versus protection	1 Hour
5.7	Tariff and non tariff barriers.	1 Hour

CEL332	TRANSPORTATION ENGINEERING LAB	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	0	0	3	2	2019

Preamble: The objective of this course is to enable students to assess the quality of various pavement materials and their suitability in highway construction. The course is designed to make student familiar with mix design and do functional evaluation of pavements.

Prerequisite: CET 206 Transportation Engineering I

Course Outcomes:

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

CO 1	Analyse the suitability of soil as a pavement subgrade material
CO 2	Assess the suitability of aggregates as a pavement construction material
CO 3	Characterize bitumen based on its properties so as to recommend it as a pavement construction material.
CO 4	Design bituminous mixes for pavement layers
CO 5	Assess functional adequacy of pavements based on roughness of pavement surface.

Mapping of Course Outcome with Programme Outcome

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

Course level assessment questions

CO1 : Determine CBR value of the given sample of soil. Comment on its suitability as a subgrade material.

CO2 : Find the impact value of the given sample of aggregates. Assess its suitability as a pavement construction material based on specifications given relevant codes/guidelines.

CO3 : Determine softening point of the given sample of bitumen.

CO4 : Determine optimum binder content of the given bituminous mix by Marshall method of mix design.

CO5 : Determine IRI value of the given road surface using MERLIN. Comment on the condition of road surface comparing standard values.

Assessment pattern

Bloom's Taxonomy	Continuous Internal Evaluation (CIE) (Marks)	End Semester Examination (ESE) (Marks)
Remember	10	15
Understand	10	15
Apply	40	40

Marks Distribution

Total marks	CIE (marks)	ESE (marks)	ESE duration
150	75	75	3 hours

Continuous Internal Assessment (CIE) pattern

Attendance: 15 marks

Continuous Assessment: 30 marks

Internal Test: 30 marks

End Semester examination (ESE)pattern

The following guidelines should be followed regarding award of marks

Preliminary Work: 15 marks

Conduct of Experiment: 10 marks

Tabulation of readings, Calculation, Result and Inference: 25 marks

Viva: 20 marks

Record: 5 marks

General Instructions regarding ESE

End semester evaluation is to be conducted under the equal responsibility of both internal and external examiners. The students shall be allowed for the ESE only on submitting the duly certified record. External examiner shall endorse the record.

Syllabus

List of Experiments

1. Test on soil : 1 session
2. Tests on coarse aggregates : 6 sessions
3. Tests on bitumen : 4 sessions
4. Mix design of bituminous mix : 1 session
5. Functional evaluation of pavement : 1 session

Course Content and Practical Schedule

Expt. No	List of Experiments	Course Outcome	No.of Hours
1	**Test on soil** California Bearing Ratio Test (soaked/unsoaked specimen)	**CO1**	3
2	**Test on Coarse Aggregate** Specific Gravity and Water Absorption Test	**CO 2**	3
3	Aggregate Impact Test		3
4	Los Angeles Abrasion Test		3
5	Aggregate Crushing Value Test		3
6	Shape Test (Angularity number, flakiness index, Elongation index, Combined flakiness and elongation index)		3
7	Stripping value of road aggregates		3
8	**Tests on Bitumen** Determination of grade of bitumen based on viscosity	**CO 3**	3
9	Softening point		3
10	Ductility of bitumen		3
11	Flash and fire point of bitumen		3
12	**Design of Bituminous Mix** Design of bituminous mix by Marshall method of mix design	**CO4**	3
13	**Functional Evaluation of Pavement** Use of MERLIN apparatus to determine road roughness	**CO5**	3

***Any twelve experiments are mandatory**

Reference Books

1. Khanna, S.K., Justo, C.E.G. and Veeraragavan, A.,"Highway Materials and Pavement Testing", Nem Chand & Bros., Roorkee

2. G. Venkatappa Rao, K. Ramachandra Rao, Kausik Pahari and D.V. Bhavanna Rao.,"Highway Material Testing and Quality Control", I.K. International.

3. L.R.Kadiyali and N.B Lal., "Principles and Practices of Highway Engineering", Khanna Publishers.

CEL 334	CIVIL ENGINEERING SOFTWARE LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		LAB	0	0	3	2	2019

Preamble: The course aims to train the students to use different software tools needed for professional practice in civil engineering. Also. the field expertise needed for undertaking the surveying activity using modern instruments and hence to prepare the necessary engineering documentation are included in this laboratory course.

Prerequisite: Civil Engineering drawing, structural analysis and design courses, surveying lab.

General Instructions to Faculty:

1. A total of 8 experiments are to be completed in the course by ensuring that at least one from each section is done.
2. The laboratory should have possession of required software and survey equipment for effective delivery of laboratory sessions
3. Periodic maintenance and calibration of various testing instruments needs to be made.
4. Use of data visualization packages needs to promoted for making various plots.

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

Course Outcome	Course Outcome Description
CO1	To undertake analysis and design of multi-storeyed framed structure, schedule a given set of project activities using a software.
CO2	To prepare design details of different structural components, implementation plan for a project.
CO3	To prepare a technical document on engineering activities like surveying , structural design and project planning.

Mapping of course outcomes with program outcomes:

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

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

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

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

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

General Instructions regarding ESE: Evaluation is to be conducted by both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

References

1. N Krishna Raju, Structural Design and Drawing, Second Edition, Universities Press (India), Private Limited, Hyderabad, 2009

2. Reference Manual of the Relevant Software

3. Satheesh Gopi, Dr. R Sathikumar, N Madhu, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education India, 2006

4. AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, US, 2015

SYLLABUS

1. Analysis and design of steel and RCC elements using any standard software used in the industry.

   Exercise 1: Analysis and design of continuous and cantilever beams

   Exercise 2: Analysis and design of multi-storied RCC framed structures.

2. Preparation of structural drawings of slabs and beams

   Exercise 3: Detailed structural drawing of one way / two-way and continuous slabs.

   Exercise 4: Detailed structural drawing of singly reinforced / doubly reinforced Beams.

   Exercise 5: Detailed structural drawing of continuous / flanged beams.

   Exercise 6: Detailed structural drawing of foundation units – isolated and combined footing (rectangular)

3. Use of Building Information Modelling tools (This section can be conducted as a demonstration.)

   Introduction to BIM process and describe the workflow in using BIM in the building lifecycle (Theory discussion – 2 hours)

   Exercise 7: Preparation of building model from a given architectural drawing of a residential unit and perform model based cost estimation

   Exercise 8: Create a schedule and import it into the 4D modelling environment, so that each activity in the schedule can be linked to an object in the model.

   Exercise 9: Develop schedules for the construction of slabs, walls, columns, beams and windows of a section of a residential building

   Exercise 10: Effect of rescheduling the activities to complete the project in minimum time frame.

4. Use of Project Management Software (MS Project/Primavera)

   Introduction to project management -CPM & PERT (Theory class-2 hours)

   Exercise 11: Preparation of Bar Chart/Gantt Charts/CPM/PERT Charts

Exercise 12: To find the critical Path based on the given set of activity / event data

Exercise 13: Practice on Resource allocation and Project Monitoring (Cost and Time).

5. Field exercise to use Total Station (This section is excluded from the End Semester Evaluation. A report of this exercise should be submitted mandatorily, at the end of the course.)

Exercise 14: Field exercise on preparation of contour map for a given terrain using advanced surveying instruments like Total Stations (The survey activity undertaken shall be of at least 5000 Sq. m)