# SEMESTER VI

# CIVIL ENGINEERING

## CORE COURSES – S6

| SLOT | COURSE NO. | COURSES | L-T-P | HOURS | CREDIT |
|------|------------|---------|-------|-------|--------|
| A | CET302 | STRUCTURAL ANALYSIS – II | 3-1-0 | 4 | 4 |
| B | CET304 | ENVIRONMENTAL ENGINEERING | 4-0-0 | 4 | 4 |
| C | CET306 | DESIGN OF HYDRAULIC STRUCTURES | 4-0-0 | 4 | 4 |
| D | CETXXX | PROGRAM ELECTIVE I | 3-0-0 | 3 | 3 |
| E | HUT300 | INDUSTRIAL ECONOMICS & FOREIGN TRADE | 3-0-0 | 3 | 3 |
| F | CET308 | COMPREHENSIVE COURSE WORK | 1-0-0 | 1 | 1 |
| S | CEL332 | TRANSPORTATION ENGINEERING LAB | 0-0-3 | 3 | 2 |
| T | CEL334 | CIVIL ENGINEERING SOFTWARE LAB | 0-0-3 | 3 | 2 |
| R/M/H | VAC | REMEDIAL/MINOR/HONOURS COURSE | 3-1-0 | 4* | 4 |
| | | TOTAL | | 25/29 | 23/27 |

## MINOR COURSES - S6

| R/M/H | CET382 | ESTIMATION, COSTING AND VALUATION | 3-1-0 | 4 | 4 |
|-------|--------|-----------------------------------|-------|---|---|
| R/M/H | CET384 | GEOTECHNICAL INVESTIGATION & GROUND IMPROVEMENT TECHNIQUES | 3-1-0 | 4 | 4 |
| R/M/H | CET386 | ENVIRONMENTAL HEALTH& SAFETY | 3-1-0 | 4 | 4 |

## HONOURS COURSES - S6

| R/M/H | CET394 | FINITE ELEMENT METHOD | 3-1-0 | 4 | 4 |
|-------|--------|-----------------------|-------|---|---|
| R/M/H | CET396 | EARTH DAMS AND EARTH RETAINING STRUCTURES | 3-1-0 | 4 | 4 |
| R/M/H | CET398 | ENVIRONMENTAL POLLUTION MODELLING | 3-1-0 | 4 | 4 |

## PROGRAM ELECTIVEI - S6

| | CET312 | ADVANCED COMPUTATIONAL METHODS | 3-0-0 | | |
|---|--------|-------------------------------|-------|---|---|
| | CET322 | GEOTECHNICAL INVESTIGATION | 3-0-0 | | |
| | CET332 | TRAFFIC ENGINEERING & MANAGEMENT | 3-0-0 | | |
| D | CET342 | MECHANICS OF FLUID FLOW | 3-0-0 | 3 | 3 |
| | CET352 | ADVANCED CONCRETE TECHNOLOGY | 3-0-0 | | |
| | CET362 | ENVIRONMENTAL IMPACT ASSESSMENT | 3-0-0 | | |
| | CET372 | FUNCTIONAL DESIGN OF BUILDINGS | 3-0-0 | | |

| 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
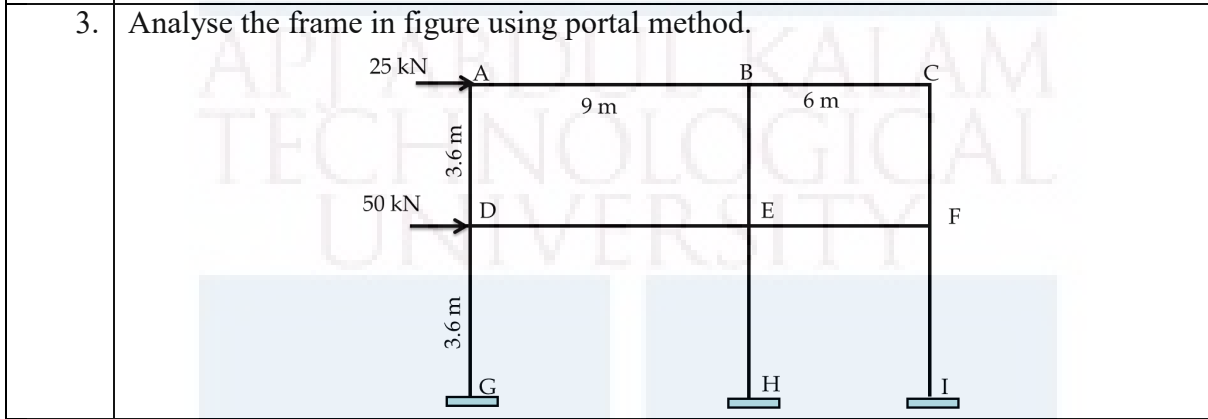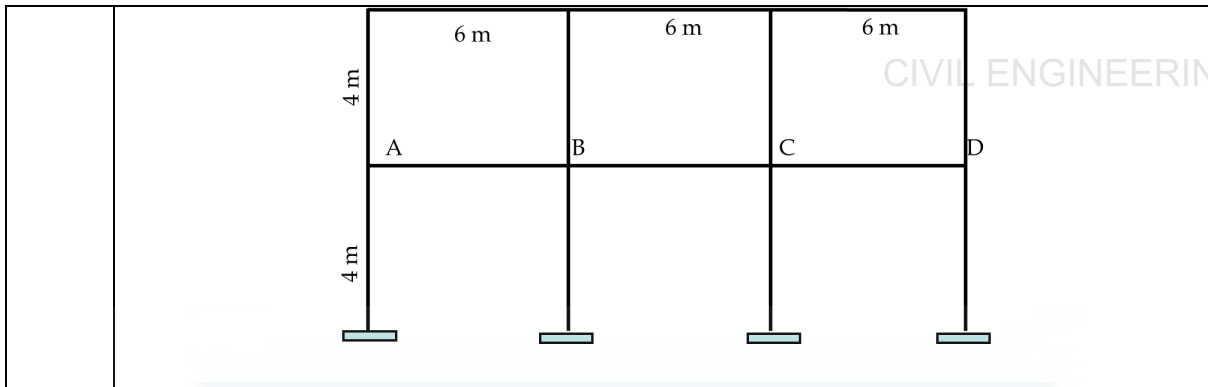Assignment/Quiz/Course project            : 15 marks

**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? |

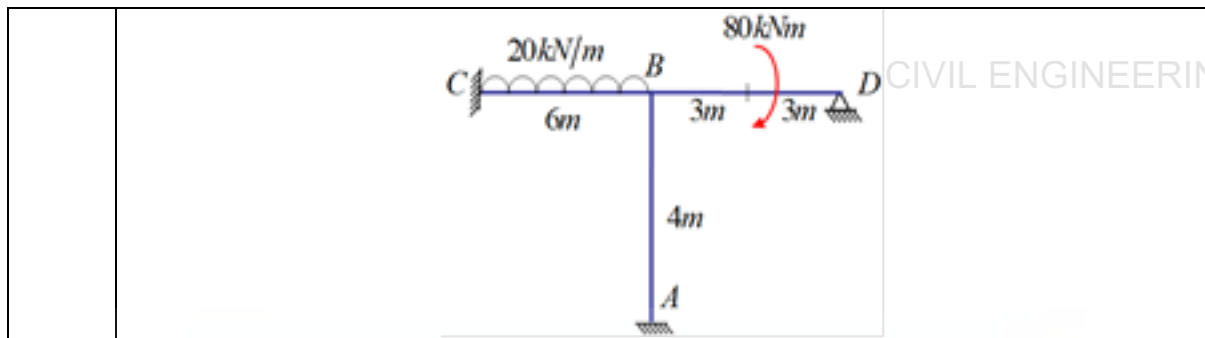| CO3: | Apply approximate methods of analysis for framed structures to ascertain stress resultants approximately but quickly. |
|---|---|
| 1. | What are the assumptions in cantilever method? |
| 2. | Total dead load is 12 kN/m and total live load is 20 kN/m on ABCD. Analyse the frame for midspan positive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

| 3. | Analyse the frame in figure using portal method. |



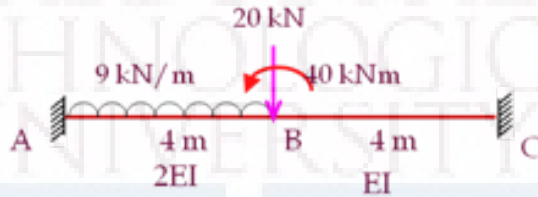| **CO4:** | **Apply the force method or displacement method to analyse structures accurately.** |
|---|---|
| 1. | Derive stiffness matrix for the degrees of freedom shown for the beam in figure.  |
| 2. | Prove that flexibility matrix is the inverse of stiffness matrix for a given set of actions and 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. |

| | |
|---|---|
| |   CIVIL ENGINEERING |
| 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.
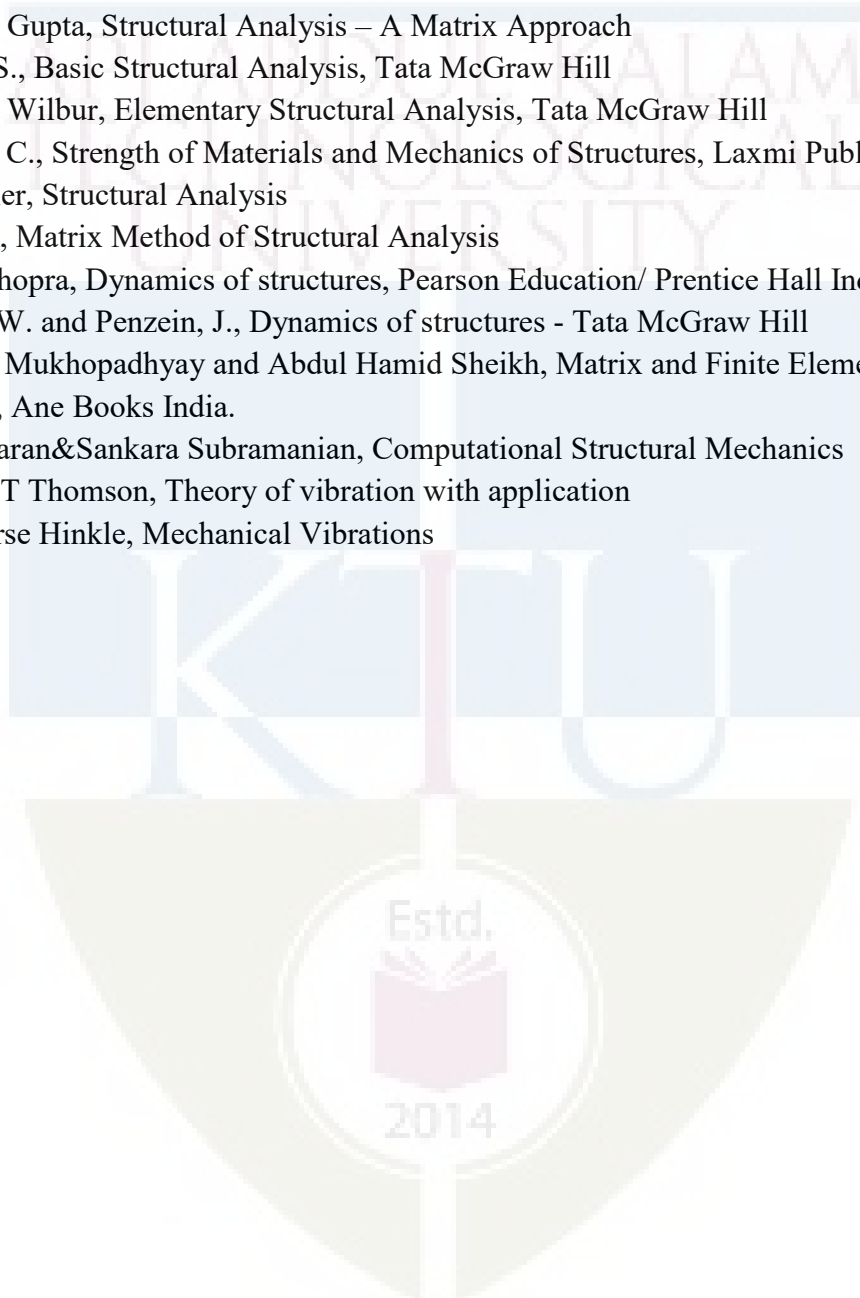
**MODULE V**

**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** <br> SIXTH SEMESTER B.TECH DEGREE EXAMINATION | | |
| **Course Code: CET302** | | |
| **Course Name: STRUCTURAL ANALYSIS II** | | |
| Max. Marks: 100 | | Duration: 3 Hours |
| | | |

<div align="center">

**PART A**

*Answer all questions; each question carries 3 marks.*

</div>

| 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. <br><br>  |
| | d) | What are the assumptions in cantilever method? |
| | e) | Derive stiffness matrix for the degrees of freedom shown for the beam in figure. <br><br>  |
| | 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) |

<div align="center">

**PART B**

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

**Module I**

</div>

| 2. | Find the plastic moment capacity of the beam shown in figure. Assume uniform section throughout . |
|---|---|
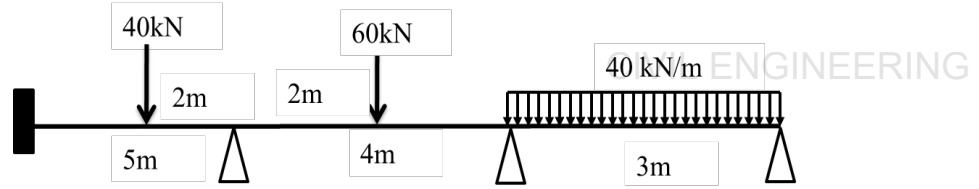
(14 marks)

| 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. |
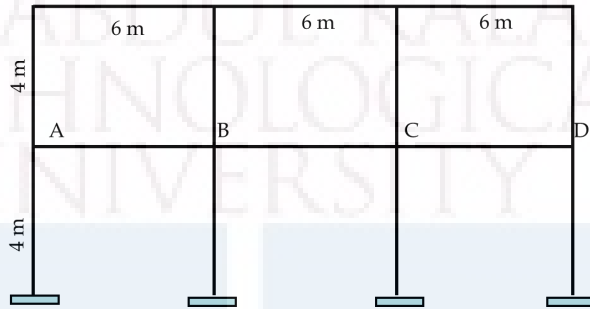


(14 marks)

**Module II**

| 4. | Analyse the beam in figure using flexibility method. |
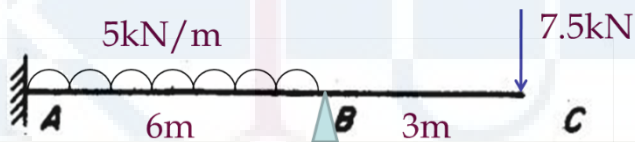


(14 marks)

| 5 | Analyse the frame in figure using portal method. |
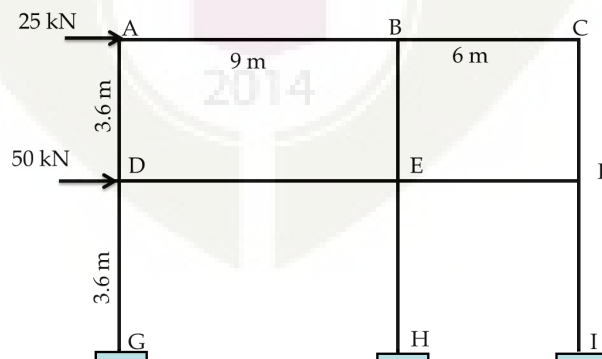


**Module III**
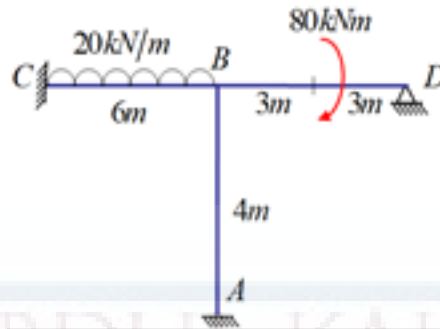
| | |
|---|---|
| 6. | Determine all the member end moments for the frame shown in figure, using stiffness method. <br><br><br><br>(14 marks) |
| 7. | Determine the displacements at B for the beam shown in figure, using stiffness method.<br><br><br><br>(14 marks) |
| | **Module IV** |
| 8. | Find all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

| 10. | Derive an expression for the free-vibration response of a damped SDOF system (Underdamped case only). <br> (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 <br> (14 marks) |
| | ********* |

| CET 304 | ENVIRONMENTAL ENGINEERING | CATEGORY | L | T | P | CREDIT | Year of Introduction |
|---------|---------------------------|----------|---|---|---|--------|----------------------|
|         |                           | PCC | 4 | 0 | 0 | 4 | 2019 |
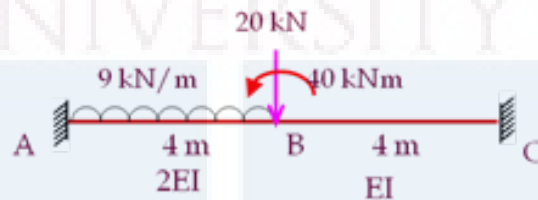
**Preamble** This course introduces students to various treatment technologies for drinking water and domestic waste water. Students will learn the role of an environmental engineer in ensuring public health. They will understand how engineering approach can enhance the environmental quality by scaling 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 | - | - | - | - | - | - | - | - | - |
| CO 4 | 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)

| 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) | **Design a 1.5 m Sarda Type Fall for a canal  carrying a discharge of 40 cumecs with the following data**<br>        Bed Level Upstream-105.0m<br>        Bed Level Downstream-103.5m          Side Slopes of canal-1:1<br>        Full Supply Level  Upstream-106.8 m          Bank level upstream-107.4 m<br>        Bed width-U/s and D/s-30 m     Safe Exit Gradient for Khosla's theory-1/5 |
| (b) | Sketch following views of the structure:<br>        (a) Half plan at top level and half at foundation level<br>        (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): |
| | <u>Details above drop:</u> |
| | 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 |
| | <u>Details below drop:</u> |
| | Full supply discharge= 5.5 cumec |
| | Bed width= 5 m |
| | Full supply level=19.6 |
| | Level at the top of the bank=20.6 |
| (b) | The bank top width is 1.8 m |
| | 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:**

o Punmia B.C.Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering. Laxmi Publications (P) Ltd 2009.
o Modi P.N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors, New Delhi 2009.
o 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 m³/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)

| 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 |

| | | PO | PO | PO | PO | PO | PO | PO | PO | PO | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CET 308 Comprehensive Course Work | 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
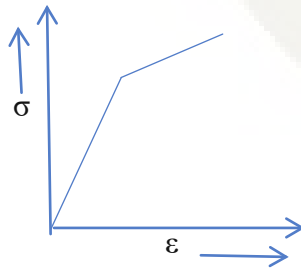


A) Rigid body behaviour
B) Perfectly plastic behaviour

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

| 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** <br> California Bearing Ratio Test (soaked/unsoaked specimen) | **CO1** | 3 |
| 2 | **Test on Coarse Aggregate** <br> Specific Gravity and Water Absorption Test | | 3 |
| 3 | Aggregate Impact Test | | 3 |
| 4 | Los Angeles Abrasion Test | | 3 |
| 5 | Aggregate Crushing Value Test | **CO 2** | 3 |
| 6 | Shape Test <br> (Angularity number, flakiness index, Elongation index, Combined flakiness and elongation index) | | 3 |
| 7 | Stripping value of road aggregates | | 3 |
| 8 | **Tests on Bitumen** <br> Determination of grade of bitumen based on viscosity | | 3 |
| 9 | Softening point | **CO 3** | 3 |
| 10 | Ductility of bitumen | | 3 |
| 11 | Flash and fire point of bitumen | | 3 |
| 12 | **Design of Bituminous Mix** <br> Design of bituminous mix by Marshall method of mix design | **CO4** | 3 |
| 13 | **Functional Evaluation of Pavement** <br> 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.
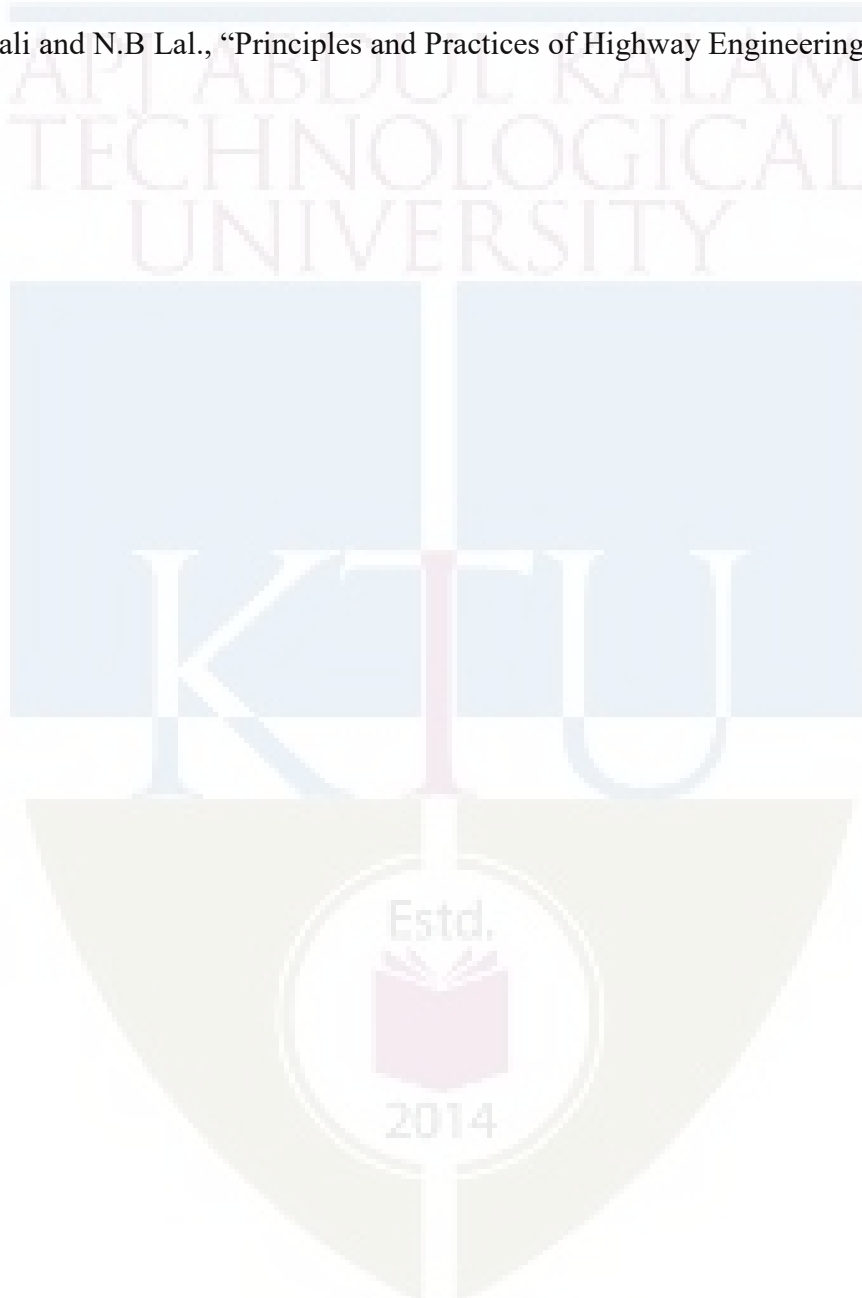
| CEL 334 | CIVIL ENGINEERING SOFTWARE LAB | CATEGORY | L | T | P | CREDIT | Year of Introduction |
|---|---|---|---|---|---|---|---|
| | | LAB | 0 | 0 | 3 | 2 | 2019 |

**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. All exercise listed in the syllabus need to be performed mandatorily.
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 |
|---|---|
| CO 1 | To undertake analysis and design of multi-storeyed framed structure, schedule a given set of project activities using a software. |
| CO 2 | 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:**
Practical examination to be conducted immediately after the second series test and covering entire syllabus given below. 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 plane truss and frames

   Exercise 3:Analysis and design of multi-storied RCC framed structures.

2. Preparation of structural drawings of slabs and beams

   Exercise 4:Detailed structural drawing of one way / two ay and continuous slabs.

   Exercise 5: Detailed structural drawing of singly reinforced / double reinforced Beams.

   Exercise 6: Detailed structural drawing of continuous / flanged beams.

   Exercise 7: Detailed structural drawing of foundation units – isolated and combined footing (rectangular)

3. Use of Building Information Modelling tools

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

   Exercise 8: Preparation of building model from a given architectural drawing of a residential unit and perform model based cost estimation

   Exercise 9: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 10:Develop schedules for the construction of slabs, walls, columns, beams and windows of a section of a residential building

   Exercise 11: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 12:Preparation of Bar Chart/Gantt Charts/CPM/PERT Charts

Exercise 13: To find the critical Path based on the given set of activity / event data

Exercise 14: Practice on Resource allocation and Project Monitoring(Cost and Time).

4. Field exercise to use Total Station

Exercise 15: 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)
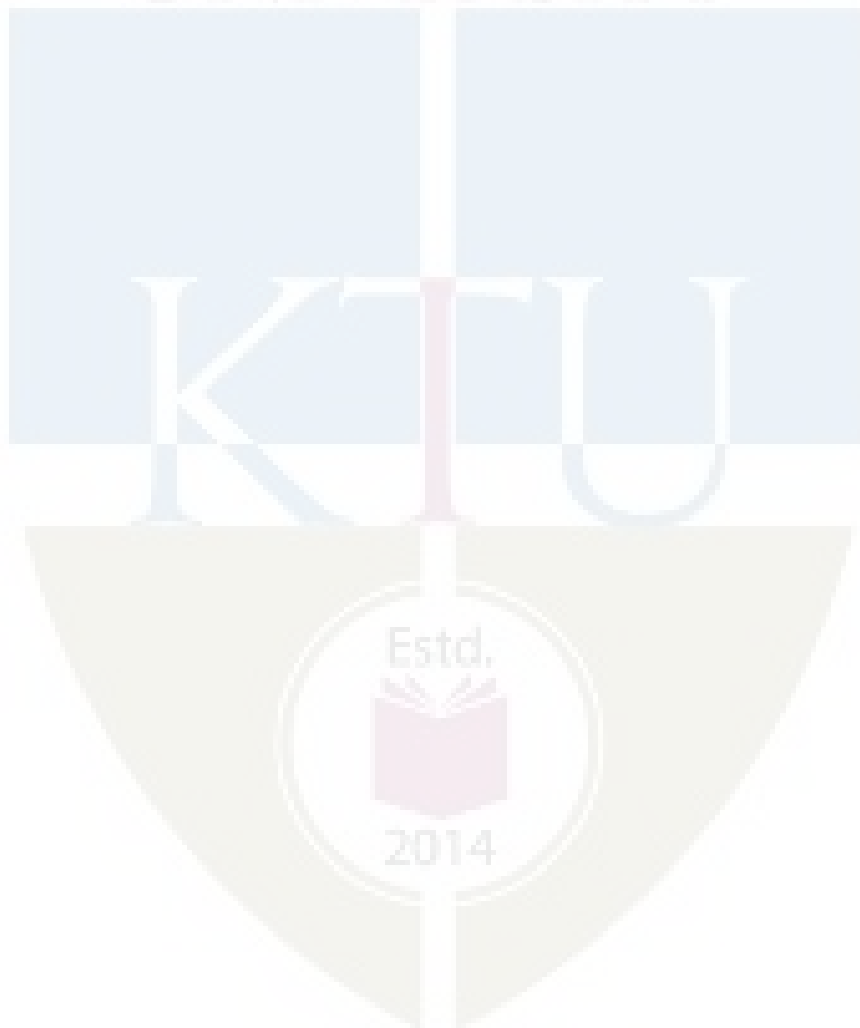
# SEMESTER VI

# PROGRAM ELECTIVE I

| CET312 | ADVANCED COMPUTATIONAL METHODS | Category | L | T | P | Credit | Year of Introduction |
|--------|-------------------------------|----------|---|---|---|--------|---------------------|
| | | PEC | 3 | 0 | 0 | 3 | 2019 |

**Preamble:** The general objective of this course is to expose the students to the fundamental concepts of different numerical computational procedures. The course aim to equip the students to find solutions for many real-world engineering problems by applying appropriate numerical methods

**Pre-requisite:** Engineering Mathematics

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

| Course Outcome | Description | Prescribed learning level |
|----------------|-------------|---------------------------|
| CO1 | Describe the procedures or principles of numerical computational approaches | Remembering/understanding |
| CO2 | Obtain the solution of simultaneous equations or eigen value problems | Applying |
| CO3 | Apply appropriate data smoothing technique for a given set of data | Applying |
| CO4 | Obtain the numerical solutions of ordinary differential equations | Applying |
| CO5 | Obtain the numerical solutions for solving boundary value problems of ordinary and partial differential equations | Applying |
| CO6 | Describe the concepts or apply discretization based solution methods | Remembering/applying |

| CET312 Advanced Computational Methods | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO1 | 1 | 1 | | | | | | | | | | |
| | CO2 | 3 | 3 | | | | | | | | | | |
| | CO3 | 3 | 3 | | | | | | | | | | |
| | CO4 | 3 | 2 | | | | | | | | | | |
| | CO5 | 3 | 3 | | | | | | | | | | |
| | CO6 | 3 | 3 | | | | | | | | | | |

**Assessment pattern**

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

**Continuous Internal Evaluation Pattern:**

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

**Note:** Enough exposure to practical examples from civil engineering should be given to the students. One assignment/course project should be based on the coding of practical civil engineering problems

**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 Level Assessment (Sample) Questions

**CO1: Describe the procedures or principles of numerical computational approaches**

1. Enlist the different errors in numerical computation
2. Explain the procedure of Newton-Raphson method for solving system of non linear equations
3. Explain the procedure of multiple linear regression
4. Compare Lagrange and Hermite interpolation
5. Explain the stability of numerical solutions of ordinary differential equations
6. Explain the procedure of modified Euler's method for solving ordinary differential equations
7. Describe the classification of partial differential equations
8. Explain Crank- Nicolson implicit scheme

9. Explain collocation method

10. Describe the principle of meshless method

**CO2: Obtain the solution of simultaneous equations or eigen value problems**

1.  Find all the eigen values and eigen vectors of the following matrix by Jacobi's transformation

$$A = \begin{bmatrix} 10 & 3 & 2 \\ 3 & 5 & 1 \\ 2 & 1 & 0 \end{bmatrix}$$

2. Apply Gauss Seidal iteration method to solve the equations

   20x+y-2z=17; 3x+20y-z= -18; 2x-3y+20z=25

**CO3: Apply appropriate data smoothing technique for a given set of data**

1. Fit the quadratic splines with M(0)=0 f''(0)=0 for the following data. Hence fiand f(2.5)

| $x$ | 0 | 1 | 2 | 3 |
|-----|---|---|----|-----|
| $y$ | 1 | 2 | 33 | 244 |

2. Evaluate $\int_0^1 \dfrac{1}{1+x^2} dx$ using (i) Simpson's 3/8 rule taking h=1/6 (ii) Weddle's rule taking h=1/6

**CO4: Obtain the numerical solutions of ordinary differential equations**

1 Apply Milne's method to find the solution of $y'= x - y^2$ in the range $0 \le x \le 1$ for the boundary condition

2.  Using fourth order Runge-Kutta method, find y for z=0.1, 0.2 and 0.3 , given $y'= xy + y^2 \, y(0)=1$

**CO5: Obtain the numerical solutions for solving boundary value problems of ordinary and partial differential equations**

1.  Solve $\nabla^2 u = 10(x^2 + y^2 + 10)$ over the square with side x=0=y; x=3=y with u=0 on the boundary and mesh length =1

2. Solve $\dfrac{d^4 y}{dy^4} + 81y = \phi(x)$ with

| $x$ | 1/3 | 2/3 | 1 |
|---|---|---|---|
| $y$ | 81 | 162 | 243 |

$y(0)=y'(0)=y''(1)=y'''(1)=0$

**CO6: Describe the concepts or apply discretization based solution methods**

1 Explain the procedure of weighted residual approaches for solving boundary value problems
2. Explain the different steps in Finite element analysis
3. Explain the characteristics of different types of elements in FEM
4. Solve $y'' + y + x = 0$ in the range $0 \le x \le 1$ by Galerkin's method. Given $y(0)=y(1)=0$

**Course Code: CET312**
**Advanced Computational Methods**
**Syllabus**

**Module I**

Introduction to numerical methods-Errors in numerical computation – System of linear algebraic equations –Ill-conditioned systems – Symmetric and Banded systems. Elimination methods – Gauss Elimination (review), Gauss Seidel iteration, Factorization method-Choleski's method. System of non linear equations – Newton-Raphson method. Eigen value problems - largest and smallest eigen values- Power method, Jacobi's transformation

**Module II**

Lagrangian and Hermite interpolation, Spline interpolation-Quadratic and Cubic splines (example of equal intervals), Data smoothing by least squares criterion- Non- polynomial models like exponential model and power equation, Multiple linear regression. Numerical integration-Newton – Cotes open quadrature formule-Trapezoidal rule, Simpson's rules, Weddles rule

**Module III**

Solution of first-order ordinary differential equations-stability of solution, Use of Taylor series, Euler's method, Modified Euler's method, Predictor-corrector method – Milne's method, Fourth order Runge-Kutta method; Higher order equations of initial value type by Runge-Kutta method.

**Module IV**

Ordinary differential equations of the boundary value type – Finite difference solution.

Partial differential equations in two-dimension-types, Elliptic equations-Laplace Equation and Poisson's equation, Parabolic equations – Explicit finite difference method –Bender-Schmidt method. Crank-Nicholson implicit method, Finite difference method – Problems with irregular boundaries

**Module V**

Weighted residual methods for initial value problems and boundary value problems – Collocation method, Subdomain method, Method of least squares, Galerkin's method.

Introduction to FEM- outline of the procedure – Types of 1D, 2D and 3D elements- element properties- polynomial form- shape function form- equilibrium and compatibility in the solution-convergence requirements, boundary conditions. Conceptual ideas of finite volume, boundary element and meshless methods.

**Text Books**

1. Grewal B. S., *Numerical Methods for Engineers & Scientists, Khanna Publishers*.

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

**References:**

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

2. Chapra S. C. and R. P. Canale, *Numerical Methods for Engineers,* McGraw Hill, 2006.

3. Smith G. D. *Numerical solutions for Differential Equations,* McGraw Hill.

4. Ketter and Prawel*, Modern Methods for Engineering Computations,* McGraw Hill.

5. Rajasekharan S., *Numerical Methods for Initial and Boundary value problems,* Khanna Publishers, 1989.

6. Terrence. J. Akai, *Applied Numerical Methods for Engineers,* Wiley Publishers, 1994.

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

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

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

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

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

**Course Plan: Advanced Computational Methods**

| Module | Topic | Course outcome addressed | No of Hours |
|---|---|---|---|
| **Module I  (7 Hours)** | | | |
| 1.1 | Introduction to numerical methods-Necessity, Errors in numerical computation | CO1 | 1 |
| 1.2 | System of linear algebraic equations, Ill-conditioned systems, Symmetric and Banded systems | CO1 | 1 |
| 1.3 | Direct and indirect methods of solution of linear equations- Gauss elimination method(review), Gauss Siedal  iteration | CO1, CO2 | 1 |
| 1.4 | Factorization method-Choleski's method | CO1, CO2 | 1 |
| 1.5 | System of non linear equations – Newton-Raphson Method | CO1, CO2 | 1 |
| 1.6 | Eigen value problems, Power method-largest & smallest Eigen values | CO1, CO2 | 1 |
| 1.7 | Jacobi's transformation | CO1, CO2 | 1 |
| **Module II  (7 Hours)** | | | |
| 2.1 | Lagrangian and Hermite interpolation | CO1, CO3 | 1 |
| 2.2 | Spline interpolation - Quadratic and Cubic splines | CO1, CO3 | 1 |
| 2.3 | Problems on interpolation | CO3 | 1 |
| 2.4 | Data smoothing by least squares criterion- Non- polynomial models like exponential model, power equation | CO1, CO3 | 1 |
| 2.5 | Multiple linear regression | CO1, CO3 | 1 |
| 2.6 | Numerical integration- Newton – Cotes open quadrature | CO1, CO3 | 1 |
| 2.7 | Problems on numerical integration | CO3 | 1 |
| **Module III (7 Hours)** | | | |
| 3.1 | Solution of first-order ordinary differential equations ; stability of solutions | CO1 | 1 |
| 3.2 | Solution of first-order ordinary differential equations by use of Taylor series. | CO1, CO4 | 1 |
| 3.3 | Euler's method | CO1, CO4 | 1 |
| 3.4 | Modified Euler's method | CO1, CO4 | 1 |
| 3.5 | Predictor-corrector methods – Milne's method | CO1, CO4 | 1 |

| | | | |
|------|-----------------------------------------------------------------------------------------------------------------------------|-----------|---|
| 3.6 | Fourth order Runge-Kutta method-Problems | CO1, CO4 | 1 |
| 3.7 | Higher order equations of initial value type by Runge-Kutta method | CO1, CO4 | 1 |
| **Module IV (7 Hours)** | | | |
| 4.1 | Ordinary differential equations of the boundary value type – Finite difference solution. | CO1, CO5 | 1 |
| 4.2 | Partial differential equations in two-dimension- types. Laplace Equation | CO1, CO5 | 1 |
| 4.3 | Poisson's Equation and its solution | CO1, CO5 | 1 |
| 4.4 | Parabolic equations – Explicit finite difference method- Schmidt method | CO1, CO5 | 1 |
| 4.5 | Crank-Nicholson implicit method | CO1 | 1 |
| 4.6 | Finite difference method – Problems with irregular boundaries | CO1, CO5 | 1 |
| 4.7 | Problems | CO5 | 1 |
| **Module V (7 Hours)** | | | |
| 5.1 | Weighted residual methods for initial value problems and boundary value problems – Collocation method – Subdomain method | CO1, CO6 | 1 |
| 5.2 | Method of least squares – Galerkin's method | CO1, CO6 | 1 |
| 5.3 | Introduction to FEM- outline of the procedure | CO1, CO6 | 1 |
| 5.4 | Types of 1-D, 2-D and 3-D finite elements | CO1, CO6 | 1 |
| 5.5 | Element properties- polynomial form- shape function form | CO1, CO6 | 1 |
| 5.6 | Equilibrium and compatibility in the solution- convergence requirements; Boundary conditions | CO1, CO6 | 1 |
| 5.7 | General awareness on finite volume, boundary element and mesh less methods  and their difference with FEM | CO1, CO6 | 1 |

**Course Code: CET312**
**Advanced Computational Methods**
**(Model question paper)**

| Qn No | Question | Marks | Course outcome (CO) Assessed |
|-------|----------|-------|------------------------------|
| | **Part A** | | |
| | **(Answer ALL Questions)** | | |
| 1 | Enlist the different errors in numerical computation | 3 | CO1 |
| 2 | Explain symmetric and banded systems | 3 | CO1 |
| 3 | Explain Hermite interpolation | 3 | CO1 |
| 4 | Describe mulitple linear regression | 3 | CO1 |
| 5 | Explain Taylor's method for solution of differential equations | 3 | CO1 |
| 6 | Explain stability of solutions of differential equations | 3 | CO1 |
| 7 | Explain Crank Nicholson implicit method | 3 | CO1 |
| 8 | State the types of partial differential equations with examples | 3 | CO1 |
| 9 | Describe the principle of meshless method | 3 | CO1 |
| 10 | Explain convergence requirements in finite element analysis | 3 | CO1 |
| | **Part B** | | |
| | **(Answer ANY ONE FULL question from each module)** | | |
| | **Module I** | | |
| 11 | Sole by Choleski's method $$\begin{bmatrix} 2 & -3 & -1 & 2 \\ -1 & -1 & 2 & -2 \\ 1 & -1 & 1 & 1 \\ 3 & 2 & -1 & -1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 15 \\ -13 \\ 4 \\ 3 \end{bmatrix}$$ | 14 | CO2 |
| 12 | Find the largest eigen value by power method $$A = \begin{bmatrix} 2 & 12 & 2 \\ 2 & 4 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$ | 14 | CO2 |
| | **Module II** | | |
| 13 | Obtain the cubic spline approximation of the given data and | 14 | CO3 |

| | | | |
|---|---|---|---|
| | determine $y(0.5)$ and $y'(0.2)$ <br><br> | | |

| $x$ | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| $y$ | -5 | -4 | 3 | 6 |

| 14 | Evaluate $\int_0^6 \dfrac{1}{1+x^2}dx$ using (i) Simpson's 3/8 rule and Weddle's rule | 14 | CO3 |
|---|---|---|---|
| | **Module III** | | |
| 15 | Find $y(0.1)$, $y(0.2)$ given $\dfrac{dy}{dx} = x - 2y =$ x - 2y, $y(0)=1$ taking $h$=0.1 using 4$^{th}$ order Runge-Kutta method. | 14 | CO4 |
| 16 | Solve $y'=1+y^2$ $y(0)=0$ Find y(0.8) and y(1) by Milne's predictor corrector method | 14 | CO4 |
| | **Module IV** | | |
| 17 | Solve the boundary value problem $xy''+y=0$, $y(1)=1, y(2)=2$ take $h$=1/4 | 14 | CO5 |
| 18 | Solve the equation $uxx + uyy = 0$ for the square mesh with boundary value as shown in figure <br><br>  | 14 | CO5 |
| | **Module V** | | |
| 19 | Solve $y''+y+x = 0$ in the range $0 \le x \le 1$ by Galerkin's method. Given $y(0)=y(1)=0$ | 14 | CO6 |
| 20 (a) | Explain in detail the steps of finite element analysis | 8 | CO1, CO6 |
| 20 (b) | Explain forms of shape functions in finite element analysis | 6 | CO1, CO6 |

| CET322 | GEOTECHNICAL INVESTIGATION | CATEGORY | L | T | P | CREDIT | Year of Induction |
|--------|---------------------------|----------|---|---|---|--------|-------------------|
|        |                           | PEC | 3 | 0 | 0 | 3 | 2019 |

**Preamble**:

Geotechnical Investigation is a course in the stream of Soil mechanics and foundation engineering. The course is aimed to impart to the students, a clear idea about how a geotechnical investigation program is to be planned and executed. It enables the students an in-depth knowledge of the various methods of geotechnical investigation and the field tests to be conducted in different situations. After the successful completion of the course, the students will be able to plan and execute the soil investigation at a site depending on the need and availability.

**Prerequisite: CE 208 Geotechnical Engineering -1**

**Course Outcomes**

| CO 1 | The students will be able to understand the procedure, applicability, and limitations of various methods of geotechnical investigation | Remembering, Understanding |
|------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| CO 2 | The students will be able to make engineering judgments and take appropriate decisions related to geotechnical investigations | Applying & Analysing |
| CO 3 | The students will be able to understand the procedure and applications of penetration tests and geophysical tests for exploration of the soil profile | Remembering, Understanding |
| CO 4 | The students will be able to choose the right soil sampling technique and analyse the dependability of samples collected | Applying & Analysing |
| CO5 | The students will be able to understand the procedure and applications of field load tests and rock quality indices. | Applying & Analysing |

**Mapping of the Course Outcomes with Programme Outcomes**

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

**Assessment Pattern**

| Bloom's Category | Continuous Assessment Tests | | End Semester Examination (Marks) |
|---|---|---|---|
| | Test 1 (Marks) | Test 2 (Marks) | |
| Remember | 15 | 15 | 30 |
| Understand | 10 | 10 | 20 |
| 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 Evaluation (ESE) 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.

Note : 1.Each part should have at least one question from each module. 2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

**Course Level Assessment Questions**

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

**Course Outcome 1 (CO1):**The students will be able to understand the procedure, applicability, and limitations of various methods of geotechnical investigation.

1. Explain the various methods adopted for preliminary investigation.
2. What are the I.S. guidelines for deciding the number, size, spacing, and depth of boreholes?
3. What are the limitations of standard penetration test?

**Course Outcome 2 (CO2):**The students will be able to make engineering judgments and take appropriate decisions related to geotechnical investigations

1. Determine the bearing capacity, from a given SPT data.
2. Explain the procedures for geotechnical investigation of a profile which shows, rejection in SPT test.
3. What are the situations in which wash boring can be used as an exploration technique?

**Course Outcome 3 (CO3):**The students will be able to understand the procedure and applications of penetration tests and geophysical tests for exploration of the soil profile

1. Explain the procedure of determination of thickness of a strata using electrical resistivity method.
2. What are the effects of water table in geophysical methods?
3. What are the limitations of seismic refraction method?

**Course Outcome 4 (CO4):**The students will be able to choose the right soil sampling technique and analyse the dependability of samples collected.

1. What are the type of soil samples in a soil investigation procedure?
2. What are the factors affecting the quality of a soil sample?
3. Explain the methods of collection of soil samples.

**Course Outcome 5 (CO5):**The students will be able to understand the procedure and applications of field load tests and rock quality indices.

1. What are the limitations of a plate load test?
2. What are the situations in which pressure meter test becomes Ideal?
3. Explain the concept of subgrade reaction.
4. Explain the methods of representing the quality of rocks is a soil investigation report.

**Syllabus**

| Module | Content |
|--------|---------|
| I | Introduction and practical importance - Objectives of soil exploration– Planning of a sub-surface exploration program –Collection ofexisting information, reconnaissance, preliminary and detailedinvestigation - I.S. and other guidelines for deciding the number, size,spacing, and depth of boreholes Methods of exploration - Open pits – Auger boring- -Wash boring,percussion drilling, rotary drilling |

| II | Sounding methods Standard Penetration Test – Procedure –corrections to be applied to observed N values – Numerical examples -Factors influencing the SPT results and precautions to obtain reliableresults – Merits/drawbacks of the test – Correlations of N value withvarious engineering and index properties of soils Static Cone Penetration Test – Procedure – Merits/drawbacks –Correlation of static CPT results with soil properties -Dynamic ConePenetration Test – Brief Procedure – Merits/drawbacks –Critical comparison of SPT, static CPT, and dynamic CPT |
|---|---|
| III | Geophysical methods – Seismic refraction method – Procedure, uses,limitations – Solution of numerical problems to estimate the velocityof seismic waves and the thickness of the upper layer of a two-layeredsoil system - Electrical resistivity method – Electrical profiling andelectrical sounding – Procedure, uses, limitationsStabilization of boreholes, Groundwater level estimation |
| IV | Soil sampling – Undisturbed, disturbed, and representative samples –Chunk and tube samples – Factors affecting sample disturbance andmethods to minimize them –Area ratio - Inside clearance – Outsideclearance - Recovery ratio –Ball check valve – Numerical Problems -Handling andtransportation of samples – Extrusion of samplesTypes of samplers – Thin-walled sampler – Piston sampler – Splitspoon sampler – Methods for collection of sand samples frombeneath the water table - Core retainers |
| V | Pressure meter test - Procedure –Uses – limitations, Flat Dilatometer Test (Brief only)Plate load test – Procedure, uses, and limitations – modulus of subgrade reaction- Solution of numerical problems using plate load test data Rock core sampling, Rock Quality Designation, Core Recovery Ratio –Bore log – Soil profile – Sub-soil investigation report |

**Textbooks:**

1. Gopal Ranjan and Rao A.S.R., "Basic and Applied Soil Mechanics", New Age International (P) Limited, New Delhi, 2002.
2. Venkata Ramaiah, "Geotechnical Engineering", Universities Press (India) Limited, Hyderabad, 2000.

**References:**

1. Arora K.R., "Geotechnical Engineering", Standard Publishers Distributors, New Delhi, 2006.
2. Joseph E. Bowles, „Foundation Analysis and Design", Mc. Graw Hill Inc., New York, 1988.
3. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Kindersley(India) Pvt. Ltd., 2013
4. Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967.

**Course content and Lecture schedule**

| Module | | Contents | Outcomes Addressed | Hours |
|---|---|---|---|---|
| I | | **Module 1** | | 7 |
| | 1.1 | Introduction and practical importance - Objectives of soil exploration – | CO1 | 1 |
| | 1.2 | Planning of a sub-surface exploration program – Collection of existing information, | CO1 | 1 |
| | 1.3 | reconnaissance, preliminary and detailed investigation | CO1 | 1 |
| | 1.4 | I.S. and other guidelines for deciding the number, size, spacing, and depth of boreholes | CO1 | 1 |
| | 1.5 | Methods of exploration - Open pits – Auger boring- | CO1 | 1 |
| | 1.6 | Wash boring, percussion drilling, rotary drilling | CO1 | 2 |
| | | **Module 2** | | 7 |
| II | | | | |
| | 2.1 | Sounding methods Standard Penetration Test – Procedure | CO3 | 1 |
| | 2.2 | corrections to be applied to observed N values – Numerical examples | CO2 | 1 |
| | 2.3 | Factors influencing the SPT results and precautions to obtain reliable results – Merits/drawbacks of the test | CO2 | 1 |
| | 2.4 | Correlations of N value with various engineering and index properties of soils | CO2 | 1 |
| | 2.5 | Static Cone Penetration Test – Procedure Merits/drawbacks | CO3 | 1 |
| | 2.6 | Correlation of static CPT results with soil properties | CO2 | 1 |
| | 2.7 | -Dynamic Cone Penetration Test – Brief Procedure – Merits/drawbacks – Critical comparison of SPT, static CPT, and dynamic CPT | CO3 | 1 |
| | | **Module 3** | | 7 |
| III | | | | |
| | 3.1 | Geophysical methods – Seismic refraction method – Procedure | CO3 | 1 |
| | 3.2 | uses, limitations | CO3 | 1 |
| | 3.3 | Solution of numerical problems to estimate the velocity of seismic waves and the thickness of the upper layer of a two-layered soil system | CO3 | 2 |
| | 3.4 | Electrical resistivity method – Electrical profiling and electrical sounding – Procedure | CO3 | 1 |
| | 3.5 | uses, limitations | CO3 | 1 |
| | 3.6 | Stabilization of boreholes, Groundwater level estimation | CO4 | 1 |

| | | **Module 4** | | 7 |
|---|---|---|---|---|
| IV | | | | |
| | 4.1 | Soil sampling – Undisturbed, disturbed, and representative samples – | CO4 | 1 |
| | 4.2 | Chunk and tube samples – Factors affecting sample disturbance and methods to minimize them – | CO4 | 1 |
| | 4.3 | Area ratio - Inside clearance – Outside clearance - Recovery ratio –Ball check valve – | CO4 | 1 |
| | 4.4 | Numerical Problems | CO4 | 1 |
| | 4.5 | Handling and transportation of samples – Extrusion of samples | CO4 | 1 |
| | 4.6 | Types of samplers – Thin-walled sampler – Piston sampler – Split spoon sampler – | CO4 | 1 |
| | 4.7 | Methods for collection of sand samples from beneath the water table - Core retainers | CO4 | 1 |
| | | **Module 5** | | 7 |
| V | | | | |
| | 5.1 | Pressure meter test - Procedure – Uses – limitations, | CO5 | 1 |
| | 5.2 | Flat Dilatometer Test (Brief only) | CO5 | 1 |
| | 5.3 | Plate load test – Procedure, uses, and limitations – | CO5 | 1 |
| | 5.4 | modulus of subgrade reaction- Solution of numerical problems using plate load test data | CO5 | 2 |
| | 5.5 | Rock core sampling, Rock Quality Designation, Core Recovery Ratio | CO5 | 1 |
| | 5.6 | Bore log – Soil profile – Sub-soil investigation report | CO1 | 1 |

**Model Question Paper**

**QP CODE:**

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

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

**Course Code: CET 322**
**Course Name: GEOTECHNICAL INVESTIGATION**

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

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

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

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

### Module 1

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

### OR

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

### Module 2

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

### OR

14. **a.** The field N value in a deposit of fully submerged fine sand was 47 at a depth of 7m. The average saturated unit weight of the soil is 19kN/m3. Calculate the corrected N value.

**b.** Explain the procedure for conducting SPT test with neat figure.

## Module 3

15. **a.** Explain the seismic refraction method

**b.** Explain the procedure to employ electrical sounding method.

**OR**

16. **a.** Explain the electrical profiling method.

**b.** Explain stabilization of borehole using Bentonite slurry.

## Module 4

17. **a.** Explain any two types of samplers used for undisturbed soil sample.

**b.** If the external diameter of a sampling tube is 75 mm and area ratio is 20%, determine the thickness of sampling tube.

**OR**

18. **a.** Explain the factors affecting sample disturbance. What are the precautions to be taken in handling and transporting soil samples?

**b.** Compute the area ratio of a thin walled tube sampler of external diameter 6.0 cm and wall thickness 2.25mm and comment on the type of soil sample obtained using this sampler.

## Module 5

19. **a.** What is a bore log and draw an example of bore log?

**b.** What are the salient features of a sub soil investigation report? With a neat sketch, explain the term 'soil profile'.

**OR**

20. **a.** ExplainPressure meter test and comment on the Uses and limitations

**b.** Two plate load tests with square plates were performed on a soil deposit. For a 30 mm settlement, the following loads were obtained. Determine the width of a square footing which would carry a net load of 1,500 kN for a limiting settlement of 30 mm.

| Width of square plate in mm | Load in kN |
|---|---|
| 300 | 38.2 |
| 600 | 118.5 |

| CET332 | TRAFFIC ENGINEERING AND MANAGEMENT | CATEGORY | L | T | P | CREDIT | Year of Introduction |
|---|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 | 2019 |

**Preamble :** The course aims to impart in-depth knowledge pertinent to traffic flow theory, traffic management measures, capacity analysis, design of road intersections and road safety**.**

**Prerequisite: CET 206** Transportation Engineering

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

| CO 1 | Identify the relationship among various traffic stream variables. (K2, K3) |
|---|---|
| CO 2 | Apply traffic management measures and regulations so as to solve issues related to traffic flow in road network. (K2, K3) |
| CO 3 | Explain the concept of capacity and LOS and its estimation for various traffic facilities (K2,K3) |
| CO 4 | Identify the need for intersection control and design of various types.(K2,K3) |
| CO 5 | Analyse causes of road accidents and suggest preventive measures (K2, K3) |

**Mapping of course outcomes with program outcomes**

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

**Assessment Pattern**

| Bloom's Category | Continuous Assessment | | End Semester Examination (marks) |
|---|---|---|---|
| | Test 1 Marks | Test 2 Marks | |
| Remember | 5 | 5 | 20 |
| Understand | 10 | 10 | 40 |
| 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):**Illustrate through diagrams the basic relationship between the fundamental variables of traffic flow.
**Course Outcome 2 (CO2):**.Suggest traffic management measures so as to avoid locking of vehicle flow due to turning traffic.
**Course Outcome 3 (CO3):**Define adjusted capacity. What are the measures of effectiveness used for urban roads and  two lane highways?

**Course Outcome 4 (CO4):**Explain the hierarchy of intersection control. What do you understand by optimum cycle length?

**Course Outcome 5 (CO5):**With neat sketches differentiate between collision and condition diagram

| | **Syllabus- Traffic Engineering and Management** |
|---|---|
| **Module 1** | **Traffic Flow Characteristics**: *Fundamental Parameters*- speed, density, volume, travel time, headway, spacing, time-space diagram, time mean speed, space mean speed and their relation. Fundamental diagrams of traffic flow. <br> *Traffic stream models*: Single Regime models - Greenshields model, Greenberg logarithmic model <br> Multi-regime models – Two and three regime linear models. |
| **Module 2** | **Regulation of Traffic** – Need and scope of traffic regulations- Motor Vehicle Act – Regulation of speed- Regulation of vehicles – Regulations concerning driver- General rules concerning traffic-  parking regulations- Enforcement of regulations. <br> **Traffic Management** – scope of traffic management measures – restrictions to turning movements – one way streets – tidal flow operations-Closing side streets – Exclusive bus lanes. |
| **Module3** | **Capacity and Level of service (LOS)**: Concept- Base capacity, Adjusted capacity, LOS definition, FactorsAffecting Capacity and LOS, Homogeneous and heterogeneous traffic conditions-vehicle types - Concept of PCU. <br> Capacity and LOSanalysis –Single lane, Intermediate laneand two lane interurban roads- Base capacity and adjustment factors- Indo HCM (2017) Guidelines <br> Capacity and LOS analysis of  Urban roads - Base conditions- Adjustment factors-Indo HCM (2017) Guidelines |
| **Module 4** | **Intersections:** At-grade intersections- basic forms- conflict points -visibility triangle- design principles- Channelization. <br> Roundabouts- Geometric layout, types- design elements. <br> Traffic Signals –Warrants- pre-timed and traffic actuated. <br> Design of signal timing at isolated intersections- Phase design-optimum cycle time (Webster's approach), green splitting- pedestrian phase -phase diagrams, timing diagram. <br> Grade separated intersection: Grade separated intersections without interchange and with interchange- Three leg interchange, Four leg interchange and multileg interchange. <br> **Traffic Control Measures** - Traffic Signs, Road Markings, and Traffic control aids. |
| **Module 5** | **Traffic Safety :** Road Safety Situation in India, Causes of road accidents – |

influence of road, vehicle, driver and environmental factors - Pedestrian Safety, Collection and statistical analysis of accident data, Collision and condition diagram,

**Road Safety Audit**- concept and need- organizations involved- stages of road safety audit (brief description only)

**Text Books:**

1.Kadiyali L.R. Traffic Engineering and Transport planning, Khanna Publishers, 2011
2. Khanna S.K and Justo C.E.G; Highway Engineering, Nem Chand Publishers, 10th Ed,2018.
3. CAO' Flaherty, Transport planning and Traffic Engineering, Elsevier, 2006.

**References**

1. Roger P. Roess, William R. McShane& Elena S. Prassas, Traffic Engineering, Fourth Edition, Prentice-Hall, 2010.
2. Pignataro L. J., Traffic Engineering – Theory and Practice, Prentice Hall, 1973.
3. C. J. Khisty and B. K. Lall, Transportation Engineering: An Introduction,Prentice- Hall India, 2002.
4. P. Chakroborty and A. Das, Principles of Transportation Engineering, PrenticeHall of India Pvt. Ltd., 2003.
5. A. D. May, Traffic Flow Fundamentals, Prentice–Hall, 1990.
6. C.S. Papacostas, Transportation Engineering and Planning, Prentice-Hall India,2002.
7.Highway Capacity Manual (HCM), Transportation Research Board, USA, 2010.
8. Indian Highway Capacity Manual (Indo-HCM), CSIR, New Delhi, 2017
9. Relevant IRC codes

**Course Content and lecture Schedule:**

| No. | Topic | Course Outcome | No. of Hrs |
|---|---|---|---|
| 1 | **Module 1** | | Total:7 |
| 1.1 | *Fundamental parameters-* speed, density, volume, travel time, headway, spacing, time-space diagram, time mean speed, space mean speed and their relation. Fundamental diagrams of traffic flow. | CO1 | 2 |
| 1.2 | **Single Regime models** - Greenshields model, Greenberg logarithmic model | CO1 | 3 |
| 1.3 | **Multi-Regime models** – Two and three regime linear models. | CO1 | 2 |
| 2 | **Module 2** | | Total: 7 |

| 2.1 | Need and scope of traffic regulations- Motor Vehicle Act – Regulation of speed- Regulation of vehicles – Regulations concerning driver-  General rules concerning traffic-  parking regulations- Enforcement of regulations. | CO2 | 4 |
|---|---|---|---|
| 2.2 | Scope of traffic management measures – restrictions to turning movements – one way streets – tidal flow operations-Closing side streets –Exclusive bus lanes. | CO2 | 3 |
| 3 | **Module 3** | | Total: 7 |
| 3.1 | **Capacity and Level of service (LOS)**: Concept- Base capacity, Adjusted capacity, LOS definition, Factors Affecting Capacity and LOS, Homogeneous and heterogeneous traffic conditions- vehicle types - Concept of PCU. | CO3 | 2 |
| 3.2 | Capacity and LOS analysis –Single lane, Intermediate lane and two lane interurban roads- Base capacity and adjustment factors- Indo HCM (2017) Approach | CO3 | 3 |
| 3.3 | Capacity and LOS analysis of  Urban roads - Base conditions- Adjustment factors-  Indo HCM (2017) approach | CO3 | 2 |
| 4 | **Module 4** | | Total: 9 |
| 4.1 | **Intersections:** At-grade intersections- basic forms- conflict points -visibility triangle- design principles- Channelization. | CO4 | 2 |
| 4.2 | **Roundabouts**- Geometric layout, types- design elements. | CO4 | 2 |
| 4.3 | **Traffic Signals** - Warrants- pre-timed and traffic actuated. Design of signal timing at isolated intersections- Phase design-optimum cycle time (Webster's approach), green splitting-pedestrian phase -phase diagrams, timing diagram. | CO4 | 3 |
| 4.4 | **Grade separated intersection:**Grade separated intersections without interchange, and with interchange- Three leg interchange, Four leg interchange and multileg interchange. **Traffic Control Measures** - Traffic Signs, Road Markings, Traffic control aids. | CO4 | 2 |
| 5 | **Module 5** | | Total: 5 |
| 5.1 | **Traffic Safety :** Road Safety Situation in India, Causes of road accidents – influence of road, vehicle, driver and environmental factors -  Pedestrian Safety, Collection and statistical analysis analysis of accident data, Collision and condition diagram, | CO5 | 3 |
| 5.2 | **Road safety audit**- concept and need- organizations involved-stages of road safety audit (brief description only) | CO5 | 2 |

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
**SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR**
Course Code: **CET332**
Course Name: **TRAFFIC ENGINEERING AND MANAGEMENT**
**Model Question Paper**

Max. Marks:100                                                                                    Duration: 3 hrs

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

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

(3 x 10=30 marks)
.

**PART B**
**(Answer one full question from each module)**

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

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

| 55 | 15 |
|---|---|

b. Explain single regime speed- density models                7

**OR**

12  a. Observers stationed at two sections XX and YY, 150m apart on a highway,   7
record the arrival times of four vehicles as shown in the accompanying table. If
the total time of observation at XX was 15 s, determine a) the time mean speed,
b) the space mean speed and c) the flow at section XX.

| Vehicle | Time of Arrival ( Seconds) | |
|---|---|---|
| | Section XX | Section YY |
| A | $T_0$ | $T_0 +7.58$ |
| B | $T_0 + 3$ | $T_0 +9.18$ |
| C | $T_0 +6$ | $T_0 +12.36$ |
| D | $T_0+12$ | $T_0 +21.74$ |

b. Using basic stream flow diagram, explain speed- density, speed- flow and flow-   7
density relationships


13  a. Mention general principles governing speed limit in urban area and rural area.   7
b. Suggest traffic management measures that can take care of the imbalance in   7
directional distribution of traffic during peak hours.

**OR**

14  Explain the aspects covered under regulation of vehicles and regulation   14
concerning driver in motor vehicles act.


15  a. Explain the adjustment factors mentioned in Indo HCM (2017) that are to be   7
considered in the capacity estimation of urban roads.

b. Differentiate base capacity and adjusted capacity of single lane interurban roads.   7

**OR**

16  a. What is level of service? What are the factors affecting capacity and level of   7
service?
b. Explain  the procedure mentioned in Indo HCM (2017) for the determination of   7
base capacity and level of service  of two lane two way interurban roads.


17  a. Draw a neat sketch of a full cloverleaf and show the movement of traffic.   7
b. Show conflict points at the following intersections

| 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 342**
**MECHANICS OF FLUID FLOW**
**(Course plan)**

| Module | Topic | Course outcome addressed | No of Hours |
|---|---|---|---|
| | **Module I  (8 Hours)** | | |
| 1.1 | Fluid flow: Types of fluid flow (Review) | CO1 | 1 |
| 1.2 | Potential flow-velocity potential and stream function | CO1 | 1 |
| 1.3 | Problems on velocity potential and stream function | CO1 | 1 |
| 1.4 | Streamlines and equipotential lines, flow net-uses and limitations | CO1 | 1 |
| 1.5 | Flow through pipes: Viscous flow - Shear stress, pressure gradient relationship<br>Laminar flow-Basic concepts, Reynold's experiment | CO1 | 1 |
| 1.6 | Laminar flow between parallel plates | CO1 | 1 |
| 1.7 | Hagen-Poiseuille equation | CO1 | 1 |
| 1.8 | Problems | CO1 | 1 |

| | **Module II  (7 Hours)** | | |
|---|---|---|---|
| 2.1 | Turbulent flow- fundamentals | CO2 | 1 |
| 2.2 | Velocity profile- computations | CO2 | 1 |
| 2.3 | Pipe roughness -friction factor- Moody's diagram; Hazen williems formula | CO2 | 1 |
| 2.4 | Head loss due to friction in pipes-Nikuradse experiment with artificially roughened pipe | CO2 | 1 |
| 2.5 | Reduction of carrying capacity of pipes with age | CO2 | 1 |
| 2.6 | Flow through pipe bends- application of linear momentum principle | CO2 | 1 |
| 2.7 | Problems on Flow through pipe bends | CO2 | 1 |
| | **Module III  (7 Hours)** | | |
| 3.1 | Open channel flow- uniform flow and critical flow computations- section factor | CO3 | 1 |
| 3.2 | Hydraulic exponents for uniform flow and critical flow | CO3 | 1 |
| 3.3 | Computation of discharge through compound channels | CO3 | 1 |
| 3.4 | Pressure distribution in curvilinear flows- spillway crest and spillway buckets | CO3 | 1 |
| 3.5 | Specific energy (review)- Application of Specific energy for channel transitions- hump and reduction in channel width | CO3 | 1 |
| 3.6 | Application of Specific energy for channel transitions- reduction in channel width | CO3 | 1 |
| 3.7 | Problems on Application of Specific energy for channel transitions | CO3 | 1 |
| | **Module IV (7 Hours)** | | |
| 4.1 | Rapidly varied steady flow-hydraulic jumps –tail water conditions -types | CO4 | 1 |
| 4.2 | Uses of hydraulic jumps for energy dissipation below spillways- jump height curve; tail water curve | CO4 | 1 |
| 4.3 | Unsteady flow through open channels- Surges in open channels- Positive surges and negative surges (concept only) | CO4 | 1 |
| 4.4 | Positive surges – derivation of equations-continuity and momentum | CO4 | 1 |

| | | | |
|---|---|---|---|
| 4.5 | Problems on Positive surges | CO4 | 1 |
| 4.6 | Unsteady flow through pipes –water hammer analysis | CO4 | 1 |
| 4.7 | Problems on water hammer analysis | CO4 | 1 |
| **Module V (6 Hours)** | | | |
| 5.1 | Experimental hydraulics- Dimensional analysis Dimensional analysis-Dimensions and dimensional homogeneity | CO5 | 1 |
| 5.2 | Rayleigh method-Problems | CO5 | 1 |
| 5.3 | Buckingham pi theorem- Problems | CO5 | 1 |
| 5.4 | Model Analysis-Dimensionless numbers, Similitude | CO5 | 1 |
| 5.5 | Model laws and scale ratios- Problems | CO5 | 1 |
| 5.6 | Scale effect, distorted and undistorted models | CO5 | 1 |

## Course Code: CET342
## MECHANICS OF FLUID FLOW
### Syllabus

**Module  I**

Fluid flow: Types of fluid flow (Review) Potential flow-velocity potential, stream function, streamlines and equipotential lines, flow net-uses and limitations
Viscous flow –Reynold's experiment; Shear stress- pressure gradient relationship - Laminar flow through pipes (Hagen-Poiseulle Equation), laminar flow between stationary parallel plates

**Module II**

Turbulent flow- Computation, velocity distribution, Head loss due to friction in pipes-Nikuradse experiment with artificially roughened pipe, Friction coefficient for laminar and turbulent flows, Moody's diagram, reduction of carrying capacity of pipes with age. Hazen William's formula. Flow through pipe bends - application of linear momentum principle

**Module III**

Open channel flow-Hydraulic exponents and section factor for uniform and critical flow, Pressure distribution in curvilinear flows- spillway crest and spillway bucket. Computation of discharge through compound channels. Application of Specific energy for channel transitions-hump and reduction in channel width

**Module IV**

Rapidly varied steady flow-hydraulic jumps –types based on tail water conditions; Uses of hydraulic jumps for energy dissipation below spillways- jump height curve; tail water curve
Unsteady flow through open channels – Surges- positive surges (problems) and concept of negative surges; Transients in pipes-water hammer

**Module V**

Experimental hydraulics- Physical modeling-Dimensional analysis- Reyleigh's method Buckingham's pi- theorem,  Similitude,  Model laws for viscous and open channel flows- Reynold's and Froude's  model law; Scale effect, distorted and undistorted models

**Text Books:**
1.  Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002.
2.  Subramanya K., Theory and Applications of Fluid Mechanics, Tata McGraw-Hill, 1993.
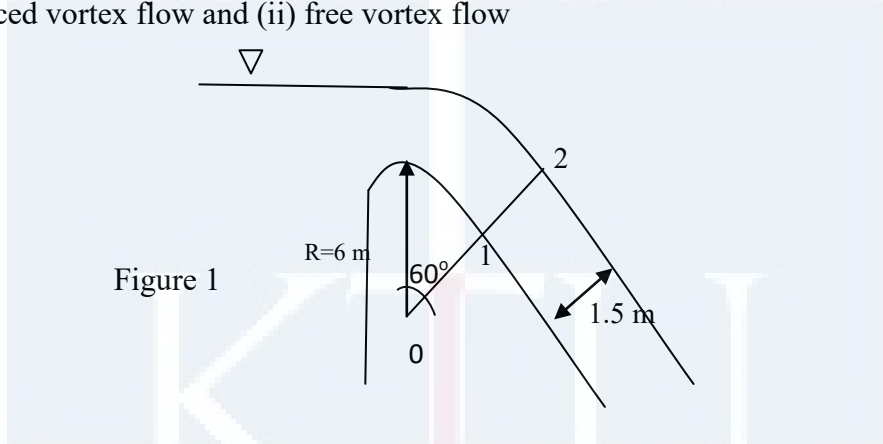3.  Subramanya K., Flow in Open channels, Tata McGraw-Hill, 2009.


**References**

1.  Streeter.V.L. Fluid Mechanics, Mc Graw Hill Publishers.
2.  Bruce R Munson, Donald F Young . Fundamentals of Fluid Mechanics, John Wiley & sons, 2011.
3.  Jain A. K., Fluid Mechanics, Khanna Publishers, Delhi, 1996.
4.  Arora.K.R. Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, 2005.
5.  Narasimhan S., A First Course in Fluid Mechanics, University Press (India) Pvt. Ltd., 2006.
6.  Frank.M.White, Fluid Mechanics, Mc Graw Hill, 2013.
7.  Mohanty.A.K. Fluid Mechanics, Prentice Hall, New Delhi, 2011
8.  Narayana Pillai,N. Principles of Fluid Mechanics and Fluid Machines, University Press, 2011.
9.  Kumar.D.N. Fluid Mechanics and Fluid power Engineering, S.K.Kataria & sons, 2013.

## Course Code: CET 342
## MECHANICS OF FLUID FLOW
### (Course Level Assessment Questions)

| CO1 | Describe and apply the  principles of potential flow and viscous flow |
|-----|-----------------------------------------------------------------------|
| 1 | Describe Reynold's experiment |
| 2 | Show that stream lines and equi potential lines intersect orthogonally |
| 3 | Crude oil of dynamic viscosity 1.5 Poise and relative density 0.9 flows through a 20 mm vertical pipe. The pressure gauges fitted at an upper point A measures 58.86 $N/cm^2$ while that fitted at another point B, 20 m below A reads 19.62 $N/cm^2$. Is the flow laminar ? Find the direction of flow and rate of flow. |
| 4 | Obtain the expression for local velocity of steady, uniform laminar flow through the space between two stationary parallel plates. Also show that the local velocity becomes average velocity at a point 0.211B from one of the plates, where B is the spacing between the plates |
| 5 | The velocity components in a two dimensional incompressible flow are $u = \dfrac{y^3}{3} + 2x - x^2 y$ and $v = xy^2 - 2y - \dfrac{x^3}{3}$. (i) Is the flow irrotational? (ii) Evaluate the potential function and stream function |

| CO2 | Perform the computations of turbulent flows through pipes and pipe bends |
|-----|--------------------------------------------------------------------------|
| 1 | Explain the use and characteristics of Moody's diagram |
| 2 | Describe the characteristics of velocity distribution in turbulent regime |
| 3 | Explain the role of surface aging in carrying capacity of commercial pipes |
| 4 | 360 l/sec of water is flowing in a pipe. The pipe is bent by $120^o$. The pipe bend measures 360 mm x 240 mm and volume of the bend is 0.14 $m^3$. The pressure at entrance is 73 $kN/m^2$ and the exit is 2.4 m above the entrance section. Find the magnitude of resultant force exerted on the bend. |
| 5 | A pipeline 30 cm diameter carries 300 l/s of petrol (density=600 kg/m3; dynamic viscosity=2.9 x $10^{-4}$ Pas). Calculate (i) the friction factor (ii) shear stress at the boundary (iii) shear stress and velocity at 5 cm from the pipe axis (iv) maximum velocity and thickness of laminar sublayer Assume the pipe to be hydrodynamically rough |

| CO3 | **Describe and apply the principles of the pressure and specific energy in open channel flow for practical applications** |
|---|---|
| 1 | Explain hydraulic exponents in open channel computation |
| 2 | Derive the relations for Pressure distribution in curvilinear flows |
| 3 | A discharge of 15 cumecs flows through a rectangular channel 3 m wide. The depth of flow is 2 m. What is the minimum width beyond which the flow depth at upstream gets disturbed ?. A smooth hump of 0.1 m is built in the channel and at this section the width is 2.8 m. Analyze the water depth at contracted section and the upstream section. |
| 4 | For the flow over a spillway with circular arc shown in Figure 1, obtain the value of pressure at point 1for discharge $q=5$ m$^3$/s/m for a constant flow depth of 1.5 m assuming (i) forced vortex flow and (ii) free vortex flow  Figure 1 |

| CO4 | **Describe and apply the principles of unsteady flow for practical applications in pipes and channels** |
|---|---|
| 1 | Explain negative surges. Give examples |
| 2 | What is water hammer in pipes ? |
| 3 | A steel pipeline is 30 cm in diameter and has a wall thickness of 3 mm. The pipe is 1000 m long and conveys a flow of 100 l/s (Relative density =0.82).The static head at the outlet is 160 m of oil. If the working stress of steel is 0.1 kN/mm$^2$, calculate the minimum time of closure of a downstream valve. For oil, $K=10^9$ Pa and for steel $E=2.14 \times 10^{11}$ Pa |
| 4 | A horizontal rectangular channel of 3 m width and 2 m water depth conveys water at 18 m$^3$/sec. If the flow rate is suddenly reduced to 2/3 of its original value, compute the height and velocity of the surge developed in the channel |

| CO5 | **Prepare physical models for performing experiments recalling the principles of fluid flow** |
|------|-----------------------------------------------------------------------------------------------|
| 1 | Describe Reyligh's method of dimensional analysis |
| 2 | Describe scale effect in physical model studies |
| 3 | Explain similitude in hydraulic model studies |
| 4 | A 1:20 spillway model has a discharge of 2.25 m³/s. what is the corresponding prototype discharge ? If a flood phenomenon takes 10 h to occur in the prototype, how long will it in the model ? |
| 5 | The discharge $Q$ over a small rectangular weir is known to depend upon head $H$ over the weir, the height of the weir $P$, acceleration due to gravity $g$, width of the weir $L$ and fluid properties $\rho$, dynamic viscosity $\mu$ an surface tension $\sigma$. Express the relationship between the variables in dimensionless form $$\frac{Q}{gH^{5/2}} = f\left[\frac{P}{H}, \frac{L}{H}, \frac{\mu}{H^{3/2}g^{1/2}\rho}, \frac{\sigma}{\rho gH^2}\right]$$ using Buckingham $\pi$ - theorem |

**Pages: 3**

**Model Question Paper**

Reg No.:………………….. QP CODE:………………..

Name:…………………………………

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

**Course Code: CET342**
**Course Name: MECHANICS OF FLUID FLOW**

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

**Part A**

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

1. Describe Reynold's experiment.
2. Explain the uses of flownet.
3. Describe the features of Moody's diagram.
4. Explain the concept of application of linear momentum principle in pipe bends.
5. Define section factor for uniform flow and critical flow computations and state their uses.
6. Describe the application of specific energy concept in channel transitions.
7. Enlist the classification of hydraulic jumps based on tail water conditions.
8. Differentiate positive surges and negative surges.
9. Explain similitude in hydraulic model studies.
10. Differentiate distorted and undistorted models.

**Part B**

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

**Module  I**

11. (a) Derive Hagen-Poiseullie equation (10Marks)

(b) Obtain the relation between mean velocity and maximum velocity of laminar flow
between parallel plates (4 Marks)

Or

12. (a). The velocity potential for a two dimensional flow is $\phi = x(2y-1)$ at P(4,5) determine

    (i) the velocity and (b) stream function               (10Marks)

12. (b) Show that the streamlines and equipotential lines are orthogonal to each other

                                          (4 Marks)

## Module II

13. The diameter of a pipe bend is 30 cm at inlet and 15 cm at outlet and the flow is turned through $120°$ in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5 m below the centre of the inlet section. Total volume of water in the bend is 0.9 m3. Neglecting friction, calculate the magnitude and direction of force exerted on the bend by water flowing through it at 250 l/sec and when the inlet pressure is 0.15N/mm$^2$

                                          (14 Marks)

Or

14. A 300 mm diameter water supply pipe had a friction factor of 0.02 when freshly laid. After 10 years of service, the friction factor was found to be 0.025. what friction factor can be expected after another 15 years ? The pipe is assumed to be in rough turbulent flow regime                                     (14 Marks)

## Module III

15. Derive the pressure distribution in curvilinear flows (a) spillway crest (ii) spillway bucket                                         (14 Marks)

Or

16. Uniform flow occurs in a 3m wide rectangular channel of bed slope 0.003 at a depth of 2.5 m. Due to sedimentation, the channel bed is raised at certain section. Calculate the maximum height of the hump which will cause any change in upstream depth. If the depth of water at upstream is raised to 2.9 m, determine the height of the hump. Take Manning's coefficient as 0.012                                   (14 Marks)

## Module IV

17. In a wide tidal river, the velocity is 0.75 m/s and the depth of flow is 1.3 m. If a tidal bore is observed to move upstream with a velocity of 4 m/s in this river, determine the velocity and depth of flow after the bore had passed                   (14 Marks)

Or

18. A steel pipeline is 30 cm in diameter and has a wall thickness of 3 mm. The pipe is 1000 m long and conveys a flow of 100 l/s (Relative density =0.82).The static head at the outlet is 160 m of oil. If the working stress of steel is 0.1 kN/mm², calculate the minimum time of closure of a downstream valve.  For oil, K=10⁹ Pa and for steel E=2.14 x10¹¹ Pa

(14 Marks)

**Module V**

19. (a) Explain Reyliegh's method of dimensional analysis. State its limitations

(8 Marks)

(b) A 1:50 spillway model has a discharge of 1.25 m³/s. what is the corresponding prototype discharge ? If a flood phenomenon takes 12 h to occur in the prototype, how long will it in the model ? (6 Marks)

**Or**

20.  A small sphere of density $\rho_s$ and diameter $D$ settles at a terminal velocity $V$ in a liquid of density $\rho_f$ and dynamic viscosity μ. Acceleration due to gravity g is known to be a parameter Express the functional relationships between these variables in the form

$$\frac{V}{\sqrt{gD}} = f\left[\frac{\rho_s}{\rho_f}, \frac{\mu}{\rho_f D\sqrt{gD}}\right]$$ using Buckingham $\pi$ - theorem (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 | | | |
| Analyse | 10 | 10 | 20 |
| Evaluate | | | |
| Create | | | |

**Mark distribution**

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

**Continuous Internal Evaluation Pattern:**

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

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

<div align="center">

**Course Level Assessment Questions**

</div>

(*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)

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)

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

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

**Prerequisite:** NIL

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

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

**Mapping of course outcomes with program outcomes (Minimum requirement)**

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

**Assessment Pattern**

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

**Mark distribution**

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

**Continuous Internal Evaluation Pattern:**

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

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

**Course Level Assessment Questions**

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

1.Explain the evolution of EIA in India

2.Explain why EIA is needed for developmental projects.

3.What are the different ways in which development projects impact the water quality and quantity?

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

1.Two municipalities in Kerala plan to set up a Common Municipal Solid Waste Management Facility (CMSWMF). Explain the procedure required for the Environmental Clearance (EC) for the project as per the EIA Notification of 2006.(All CMSWMFs are category B projects)

2.Describe the procedure for obtaining environmental clearance according to EIA notification 2006.

3.The Environment (Protection) Act, 1986 is called an umbrella legislation. Substantiate the statement.

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

1.Prepare a simple checklist for assessment of socio economic impact due to the development of a highway.

2.Explain overlay mapping as an EIA method

3.Explain how to predict the impact of a highway project on air quality

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

1.Explain the Terms of Reference (ToR) for EIA report of a highway project

2.Explain the structure of EIA report

3.Explain the importance of an environmental management plan.

**CO5: To be able to conduct an environmental audit**

1.Explain the need for environmental auditing

2.What are the different types of environmental audits?

3. Explain the importance of ISO 14001 standard.

**SYLLABUS**

**Module 1**

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

**Module 2**

Environmental clearance process in India: Screening, Scoping, Public Consultation, Appraisal-Form1-Category of projects-Generic structure of EIA report- Terms of Reference (ToR) -Types of EIA: strategic, regional, sectoral, project level- Rapid EIA and Comprehensive EIA- Initial Environmental Examination (IEE)

**Module 3**

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

**Module 4**

Environmental Management Plan (EMP): Goal and purpose- Importance of EMP- Content of an EMP- Role of environmental monitoring program
Environment Audit: need for audit- audit types and benefits- environmental audit procedure
ISO 14001 standards: Importance, salient features - Stages in implementation- Benefits

**Module 5**

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

**Text Books:**

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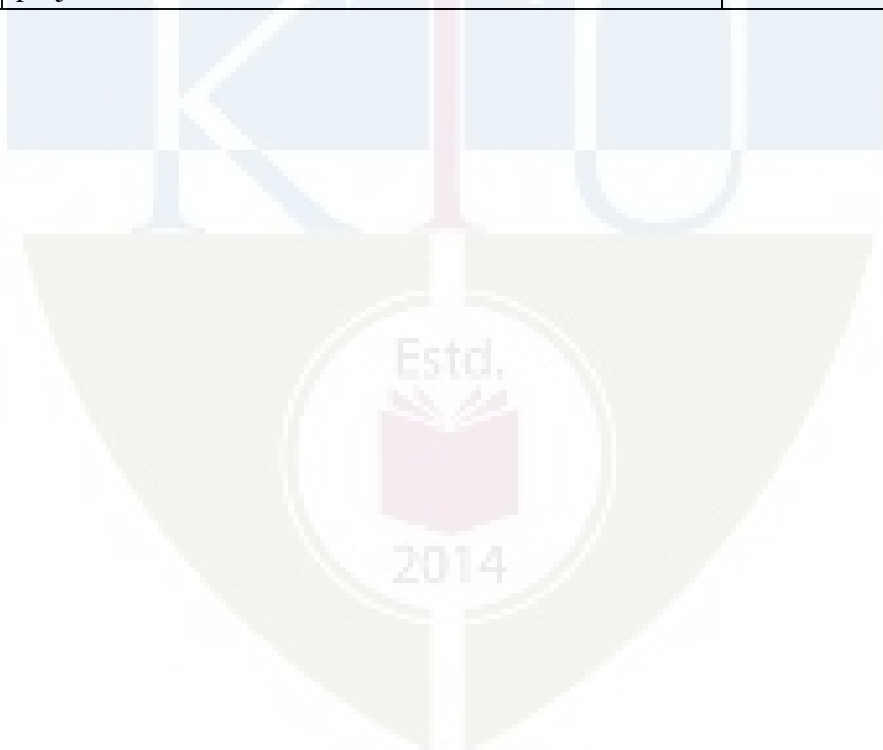3. Environmental Impact Assessment, 2003, Y.Anjaneyulu, B.S Publications

**References:**

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

**Lecture Plan- Environmental Impact Assessment**

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

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

**Model Question Paper**

Reg No.:_____                    Name:_____

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

**Course Code: CET362**
**Course Name: ENVIRONMENTAL IMPACT ASSESSMENT**

Max. Marks: 100                                              Duration: 3 Hours

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

1. Explain the need for EIA

2. Why environmental (protection) act, 1986 is called an umbrella act?

3. Discuss screening of projects

4. What is rapid EIA?

5. What is ad hoc method for impact assessment?

6. How to predict the impact of a proposed food industry on the water quality of a nearby river

7. Explain the benefits of an environmental audit

8. What is ISO 14001 standard?

9. What are the impacts of a highway project on local air quality

10. Discuss the environment monitoring program for a quarry mining industry.

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

11. (a) Discuss environmental standards for water, air and noise          (6 Marks)

    (b) Discuss evolution of EIA in India                                 (8 Marks)

                                        OR

12. (a) DiscussAir (Prevention & Control of Pollution) Act 1981          (5 Marks)

    (b) Explain salient features of EIA notification 2006                 (9 Marks)


13. (a) Discuss environmental clearance process in India                 (10 Marks)
    (b) What is Form-1 ?                                                  (4 Marks)
                                        OR

14. (a) What is Initial Environmental Examination? (5 Marks)

(b) Explain different types of EIA (9 Marks)

15. (a) Discuss in detail EIA methodologies (10 Marks)

(b) How can air quality modelling help in assessing the impact on air (4 Marks)

OR

16. (a) Explain the steps to assess the impacts on the ecological environment

due to a project (7Marks)

(b) Explain the steps involved in assessment of impacts on the water environment.

(7 Marks)

17. (a) What are the different types of Environmental Audit? (5 Marks)

(b) Discuss the content of an environment management plan .(9 marks)

OR

18. (a) Discuss the salient features of an Environmental Monitoring Plan (5 Marks)

(b) Explain in detail the procedure for conducting an environmental audit (9 Marks)

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

OR

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

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

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

**Pre-requisite:** CE204 Construction Technology

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

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

| CET372 Functional Design of Buildings | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO1 | 3 | 3 | | | | | | | | | | |
| | CO2 | 3 | 3 | | | | | | | | | | |
| | CO3 | 3 | 3 | | | | | | | | | | |
| | CO4 | 3 | 3 | | | | | | | | | | |
| | CO5 | 3 | 3 | | | | | | | | | | |

**Assessment pattern**

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

**Continuous Internal Evaluation Pattern:**

Attendance                                              :        10marks

Continuous Assessment Test (2numbers)    :        25 marks

Assignment/Quiz/Course project                :        15marks

**Total**                                                  :        **50marks**

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

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

Course Outcome 1 (CO1)
1. Develop an understanding of acoustical design and noise control techniques
2. Applications of acoustics
3. Explain the acoustical considerations for offices, hospitals and industrial buildings

Course Outcome 2 (CO2)
1. Explain the purposes of lighting
2. Explain the basic concepts of natural and artificial lighting
3. Explain the different methods used for the design of natural lighting
4. Explain the different methods used for the design of artificial lighting

Course Outcome 3 (CO3)
1. Evaluate the principles involved in the design of buildings for thermal comfort
2. Explain the influence of climate on design of buildings
3. Compute solar radiation on different surfaces
4. Describe thermo physical properties of buildings

Course Outcome 4 (CO4)
1. Describe the basic concepts for electrical load calculation of structures
2. Explain the basic criteria for plumbing design
3. Calculation of HVAC load
4. Explain the functioning of elevators and escalators
5. Understand the rough cost estimation

Course Outcome 5 (CO5)

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

**Course Code: CET 372**
**FUNCTIONAL DESIGN OF BUILDINGS**
**Syllabus**

**Module I**

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

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

**Module II**

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

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

**Module III**

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

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

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

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

**Module IV**

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

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

**Module V**

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

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

**Text Books and References:**

1. Knudsen V.O. and Harris C.M., Acoustical Design in Architecture, John Wiley,1980

2. M David Egan , Architectural Acoustics, J.Ross Publishing,2007

3. Marshall Long, "Architectural Acoustics", Second Edition, Academic Press, Waltham, USA, 2014

4. Bureau of Indian standards, Handbook on Functional Requirement of Buildings – SP:41(S and T)-1987

5. Pritchard, D.C., "Lighting", Longman Scientific & Technical, Harlow,1995.

6. Benjamin Evans, "Daylight in Architecture", McGraw - Hill Book Company, Newyork,1981.

7.Koenigseberger, Manual of tropical Housing and Building Part I – Climatic design, Orient Longman,2011

8. AjithaSimha.D, Building Environment, Tata McGraw Hill Publishing Co., New Delhi,1985

9. Jain. V.K., "Design and Installation of Services in Building complexes &High Rise Buildings", Khanna Tech. Publishers, New Delhi,1986.

10. National Building Code of India (NBC2016)

11. Wayne Forster and Dean Hawkes, "Energy Efficient Buildings: Architecture, Engineering, and Environment". W.W. Norton Company Inc.2002.

12. Bureau of Energy Efficiency, India. Design Guidelines for Energy Efficient Multi-Storey Buildings,2014.

| Module | Topic | Course outcome addressed | No of Hours |
|--------|-------|--------------------------|-------------|
| **Module I  (8 Hours)** | | | |
| 1.1 | Acoustical / Sonic Environment and acoustical comfort: Sound, Nature of sound- Behavior of sound in enclosed spaces | CO1 | 1 |
| 1.2 | Concept of Geometric Acoustics-Reflection of sound and their applications- Absorption of sound-Sound absorption coefficient- | CO1 | 1 |
| 1.3 | Human Audibility range-Reverberation & Reverberation Time Calculation- Flanking paths. Sound absorption-materials and fixings. Reverberation-Sabine's formula-Eyrings modification. | CO1 | 2 |
| 1.4 | Basic design of the elements for the required degree of sound insulation- Air and structure born noises-equivalent noise levels- day and night equivalent | CO1 | 1 |
| 1.5 | Acoustics, applications: Measures of noise control- Source-path and receiving end. TL value and computation of TL value, Acoustical defects- | CO1 | 1 |
| 1.6 | Acoustical design of auditoriums and small lecture halls. Acoustical considerations of offices, hospitals and Industrial buildings. | CO1 | 2 |
| **Module II  (6 Hours)** | | | |
| 2.1 | Natural lighting: Visual task requirements, Units of Light, Light, Vision and Buildings | CO2 | 1 |
| 2.2 | Standards of Lighting and Visual comfort-The sky as a source of light, Daylight factor, Daylight penetration-Calculation of daylight factor. | CO2 | 1 |
| 2.3 | Design of side-lit windows-BIS and CBRI methods-skylights | CO2 | 1 |
| 2.4 | Artificial lighting: Artificial lighting- illumination requirements- lux meter – lamps and luminaries – polar distribution curves | CO2 | 1 |
| 2.5 | Color temperature and color rendering index- glare - Design of artificial lighting – lumen method – point by point method. Basic idea of street lighting and outside lighting | CO2 | 2 |
| **Module III  (8Hours)** | | | |

| 3.1 | Thermal comfort: Factors affecting thermal comfort- effective temperature | CO3 | 1 |
|------|---------------------------------------------------------------------------|-----|---|
| 3.2 | Thermal comfort indices-ET-CET Charts- Bioclimatic chart-Psychrometry and Psycrometric chart. | CO3 | 1 |
| 3.3 | Earth-Sun relationship: Sun's apparent movement with respect to the earth. Solar angles | CO3 | 1 |
| 3.4 | Computation of solar radiation on different surfaces-solar path diagram-shadow-throw concept and design of shading devices | CO3 | 1 |
| 3.5 | Thermal design of buildings: Thermo physical properties of building materials and thermal control- Passive andactive building design- Steady and periodic heat flow through building envelope. | CO3 | 1 |
| 3.6 | Design approaches: Climate conscious designs- Climatic zones inIndia-orientationandshapeofbuildingsindifferentclimatic zones | CO3 | 2 |
| 3.7 | Passive solar-Active solar and Active approaches. Requirements of buildings in tropical areas-Thermal insulation | CO3 | 1 |
| **Module IV (7 Hours)** | | | |
| 4.1 | Functional elements: Concept for electrical load calculation of structures | CO4 | 1 |
| 4.2 | Basic criteria for plumbing design | CO4 | 1 |
| 4.3 | Basic concept of HVAC load calculation | CO4 | 1 |
| 4.4 | Functional protection: Causes of fire, Mechanism of fire spread in buildings, classification of fire-High temperature effects and combustibility of building materials and structure- Fire alarm system, and means of escape. Firefighting installations | CO4 | 2 |
| 4.5 | Basic concept of functioning of elevators and escalators and basic cost estimation ofservices. | CO4 | 2 |
| **Module V (6Hours)** | | | |
| 5.1 | Functionality as per Vastusastra: Basic concepts- Governing criteria of functionality - Energy pattern | CO5 | 1 |
| 5.2 | Understand traditional techniques in Tropical climate with vernacular buildings in Kerala as case study | CO5 | 2 |
| 5.3 | Innovative concepts of functionality: Concept of green building-case studies on low energy and green buildings- | CO5 | 2 |
| 5.4 | Concepts of Intelligent building- Thirsty concrete- Blue roads-self healing concrete | CO5 | 1 |

**MODEL QUESTION PAPER**

Reg. No.:_____                Name:_____

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

**Course Code: CET372**
**Course Name: FUNCTIONAL DESIGN OF BUILDINGS**

Max.Marks: 100                                              Duration: 3hours

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

1. Write briefly about the audibility range of human beings.                     (3 Marks)
2. Discuss any three common acoustical defects seen in an auditorium.          (3 Marks)
3. What are the advantages and disadvantages of sky lighting?                  (3 Marks)
4. Briefly describe polar distribution curves                                  (3 Marks)
5. What are the thermal insulating materials used to maintain comfortable conditions inside a
   building?                                                                   (3 Marks)

6. What do you understand by the following (i) Solar Constant (ii) Solar Azimuth
   (iii) Solar Altitude                                                        (3 Marks)

7.  Write short note on "Handling capacity of Lifts"                           (3 Marks)

8. Briefly describe firefighting installations                                 (3 Marks)

9. Describe self healing concrete.                                             (3 Marks)

10. List out the advantages of self healing concrete.                          (3 Marks)

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

### Module – 1

11. (a) TL value of a 16m$^2$ solid wall is 45 dB. If a hole of 2 cm$^2$ is drilled through it, find the reduction
    in TL value?                                                               (10 Marks)

    (b) Discuss how the TL value of a separating wall varies with its mass.      (4 Marks)

12. (a)  Explain how sound intensity varies with distance from a point source

    I.    In free field

    II.    In a reverberant field                              (8 Marks)

(b) What you mean by Acoustical Day Time and Acoustical Night Time. Explain the concepts of $L_{eq}$ and $L_{dn}$? (6Marks)

## Module – 2

13. (a) Explain the procedure of design of Artificial lighting by Lumen Method.     (7 Marks)

(b) A point source of light has an intensity 2000 candela in the vertically downward direction. The intensity reduces with the angle and reaches 1000 cd at the horizontal direction (90degrees with vertical). If the source is mounted 4m above the working plane, find the illumination due to this light source at points (i) directly under the lamp (ii) at 3m away in the same plane.

                              (7 Marks)

14. (a) Define the different components of daylight factor?          (6 Marks)

(b) What do you understand by the concepts Passive solar design, Active solar design and active design?          (8 Marks)
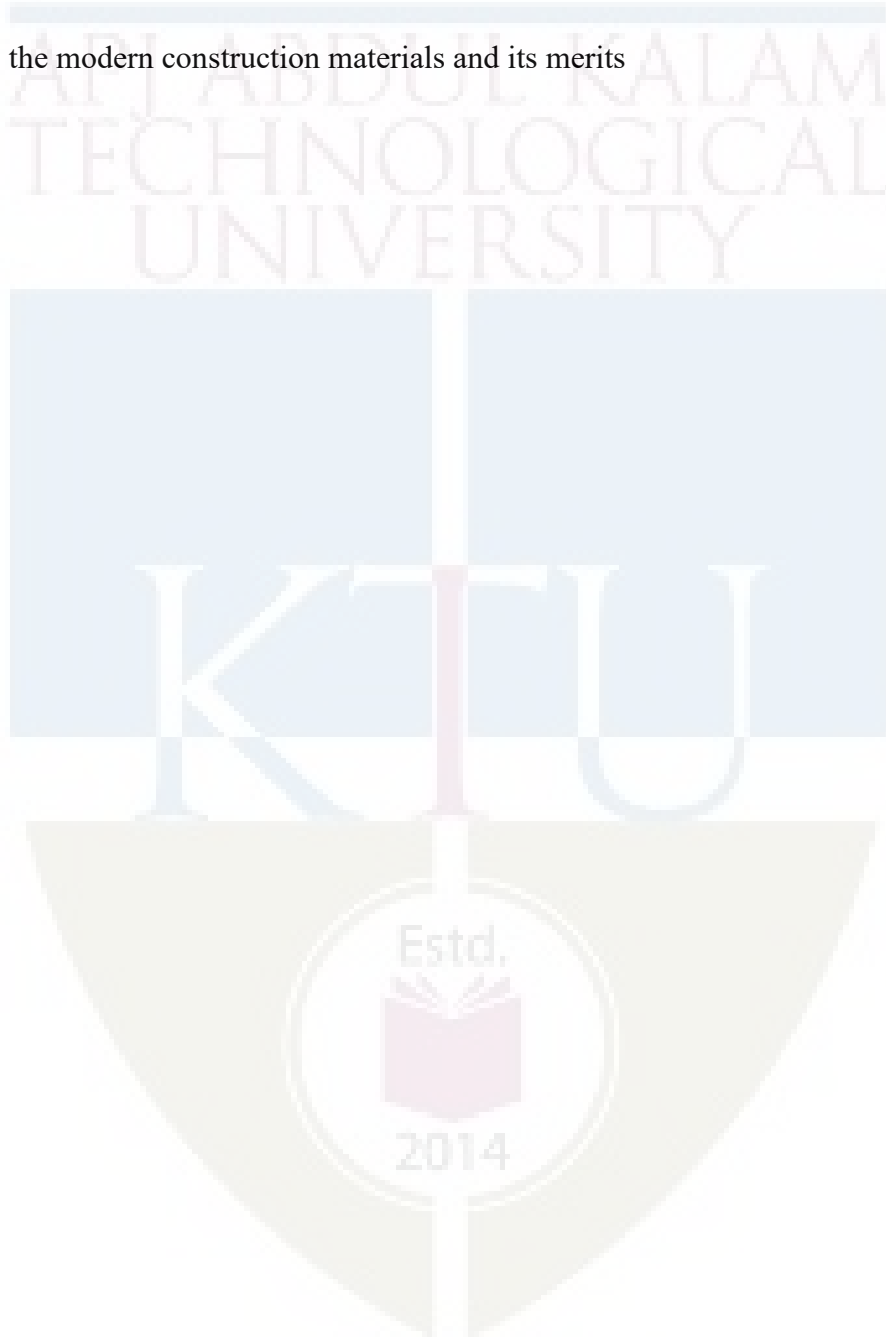
## Module – 3

15. (a) Explain the considerations to be made in achieving thermal comfort in hot & dry and Warm and humid regions?          (7 Marks)

(b) Explain the concept of shadow angles and shadow throws. How shadow throws are used in the design of shading devices?          (7 Marks)

16. (a) Explain the concept of comfort zone based on Bio-climatic chart     (7 Marks)

(b) What is Psychrometry? What are the usual input parameters to a Psychrometric chart? What are the various informations we get from a Psychrometric chart?     (7 Marks)

## Module – 4

17. Explain the features, operation arrangements, location and types of Elevators in public buildings. (14 Marks)

18. Explain the high temperature effects and combustibility of building materials and structures

                              (14Marks)

**Module – 5**

19. (a) Explain the concepts of green building.                                  (7 Marks)

    (b) Describe LEED and GRIHA ratings for the evaluation of green buildings.        (7 Marks)

20. Describe the modern construction materials and its merits                     (14 Marks)

# SEMESTER VI

## MINOR

| CET382 | ESTIMATION, COSTING AND VALUATION | CATEGORY | L | T | P | CREDIT | Year of Introduction |
|---|---|---|---|---|---|---|---|
| | | VAC | 3 | 1 | 0 | 4 | 2019 |

**Preamble:** The course introduces the various types of estimation, specification writing, analysis of rate and various methods to determine the valuation of building. It enables the students to prepare the detailed estimate of various items of work related to civil engineering construction. This course trains the student to find out the valuation of building by various methods.

**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 | Explain the specifications for various items of work associated with building construction | Understanding |
| CO2 | Analyse the unit rates of different items of work associated with building construction | Applying |
| CO3 | Prepare the approximate estimate of building | Applying |
| CO4 | Prepare detailed estimates of buildings and the bar bending schedules for R.C.C works | Applying |
| CO5 | Describe various principles and methods of valuation | Understanding |
| CO6 | Determine the valuation of buildings by different methods | Analyse |

**Mapping of course outcomes with program outcomes**

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

**Assessment Pattern**

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

**Mark distribution**

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

**Continuous Internal Evaluation Pattern:**

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

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

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

**Course Level Assessment Questions**

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

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

**CO2:** Analyse the unit rates of different items of work associated with building construction
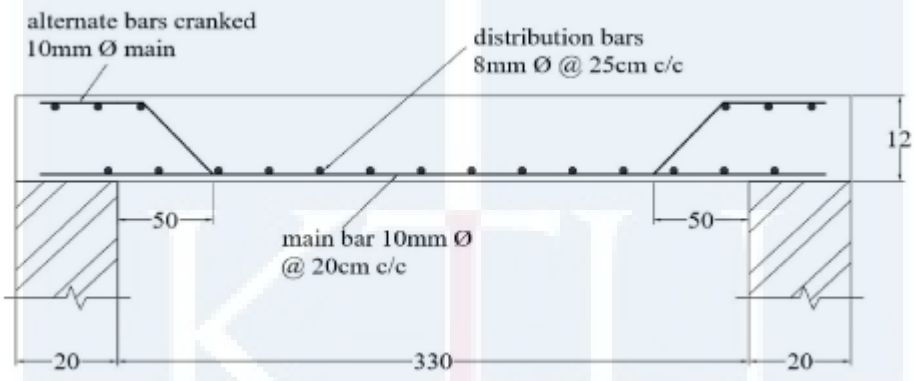
| | |
|---|---|
| 1. | Explain DAR and DSR. |
| 2. | Develop rate analysis for DSR item No.5.3, Reinforced cement concrete work with 1:1.5:3 (3 graded stone aggregate 20 mm nominal size) in beams, suspended floors, roofs having slope up to 15° landings, above plinth level up to floor five level, excluding 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. |

**CO3:** Prepare the approximate estimate of building

| | |
|---|---|
| 1. | Differentiate plinth area estimate and cubic content estimate |
| 2. | Prepare the approximate estimate of building project with total plinth area of all building is 800sqm from the following data<br>    a) Plinth area rate₹. 45000 per sqm<br>    b) Cost of water supply @7.5% of cost of building<br>    c) Cost of sanitary and electrical installations each @ 7.5% of cost of building<br>    d) Cost of architectural features @ 1% of cost of building |

| | |
|---|---|
| | e) Cost of roads and lawns @5% of cost of building<br>f) Cost of PS and contingencies @4% of cost of building<br>Determine the total cost of building project |

**CO4:** Prepare detailed estimates of buildings and the bar bending schedules for R.C.C works

| | |
|---|---|
| 1. | Explain bar bending schedule. State its uses |
| 2. | Write the unit of measurement of (i) Carpentry fittings (ii) Pointing of Brick wall |
| 3. | Calculate the quantity of RCC and Prepare a bar bending schedule of the slab of size 330cm x 550cm (internal dimensions) shown in the figure. (All dimensions are in centimeters)<br> |
| 4. | Prepare detailed estimate for the following items of work for the construction of residential building shown below<br>a) RRM for foundation and basement<br>b) RCC works<br>c) Inside and outside plastering |
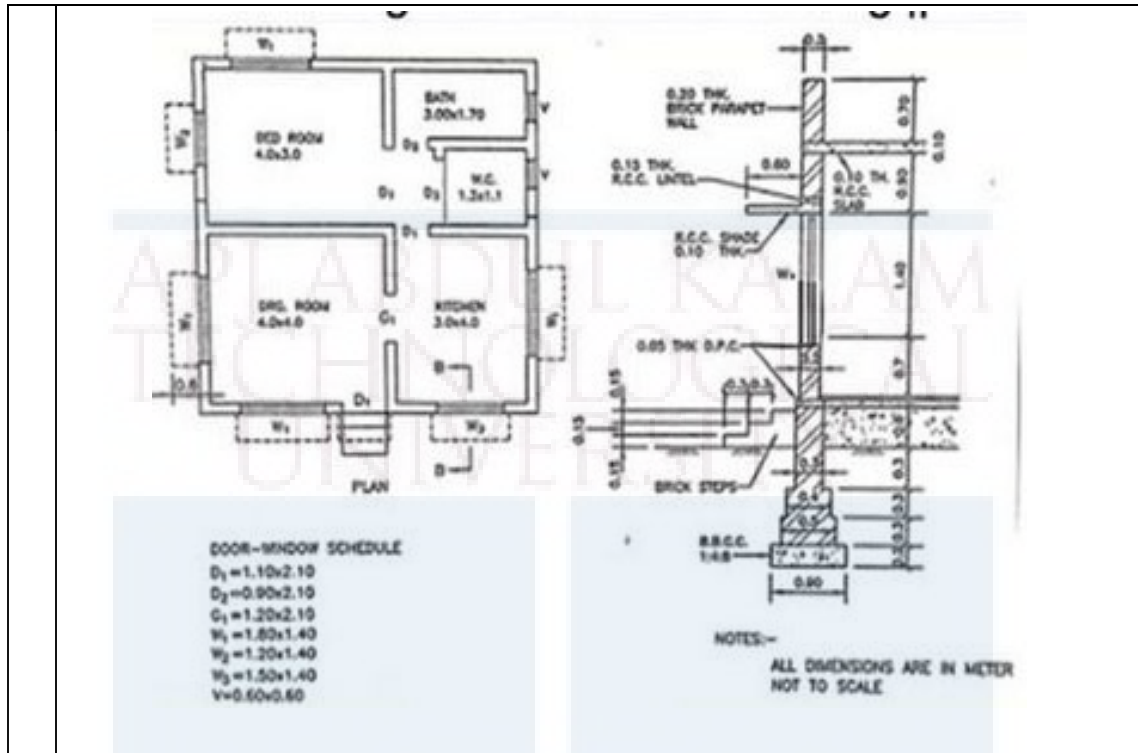
**CO5:** Describe various principles and methods of valuation

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

**CO6:** Calculate the value of buildings by different methods

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

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

## SYLLABUS

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

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

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

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

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

**Text Books:**

1. B. N. Dutta, Estimation and Costing in Civil Engineering, UBS publishers
2. Rangwala, Estimation Costing and Valuation,Charotar publishing house pvt. ltd
3. Dr. S. Seetha Raman, M.Chinna Swami, Estimation and Quantity Surveying, Anuradha publications Chennai.
4. M 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 orlatest

**Lecture Plan**

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

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

**MODEL QUESTION PAPER**

Reg.No.: _____          Name: _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SIXTH SEMESTER B.TECH. DEGREE EXAMINATION

**Course Code: CET382**

**Course Name: ESTIMATION, COSTING AND VALUATION**

Max.Marks:100                                                                 Duration: 3Hours

## PART A

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

1.  a) Differentiate revised estimate and supplementary estimate

    b) What are the principles of specification writing?

    c) Explain the use of data book and schedule of rates

    d) What are the important points to be noted while preparing contract document?

    e) In a simply supported beam of depth 450mm is provided with a 3, 20mm diameter bar at bottom, in this one bar is provided as bendup bar near both the supports. 10mm stirrups are provided with top and bottom cover 25mm. Calculate the additional length provided for bend up in both end. If the (i) bendup angle is $45^o$ and (ii) bendup angle is $30^o$.

    f) Write the unit of measurement of (i) DPC using waterproofing compound (ii) Iron work for window (iii) Water proof Painting above roof slab

    g) Differentiate book value and market value

    h) Differentiate depreciation and obsolescence

    i) Explain how will you find out the valuation of land by hypothetical building scheme

    j) Explain the depreciation method of valuation

## PART B

*Answer one full question from each module (Assume any missing data suitably)*

### Module I

2.  a) Prepare approximate estimate of a public building having plinth area equal to1800 sq.m.

i. Plinth area rate as ₹. 35,000 / sq. m.
ii. Special architectural treatment = 3% of cost of building.
iii. Water supply and sanitary installation = 5% of cost of building.
iv. Electric installation =14% of cost of building.
v. Other services = 5% of cost of building.
vi. Contingencies = 3% of overall cost of building.
vii. Supervision charges = 8% of overall cost of building. (10marks)

b) Differentiate detailed estimate and preliminary estimate. What are the documents to be accompanied with detailed estimate? (6marks)

OR

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

## Module II

4. a) What are the factors affecting the rate of a particular item of work. (6 marks)

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

Details of cost for 1 cum.

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

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

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

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

Sundries: 14.3LS @₹2.00/LS (10marks)

OR

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

## Module III

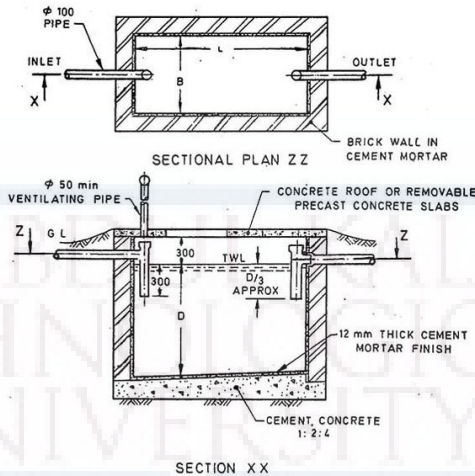6. Prepare the detailed estimate of the following items of the building. Refer Fig. No. 1

(22 marks)

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



Plan

\* All dimensions are in meter

FIG. NO. 1

Section of wall at A-A
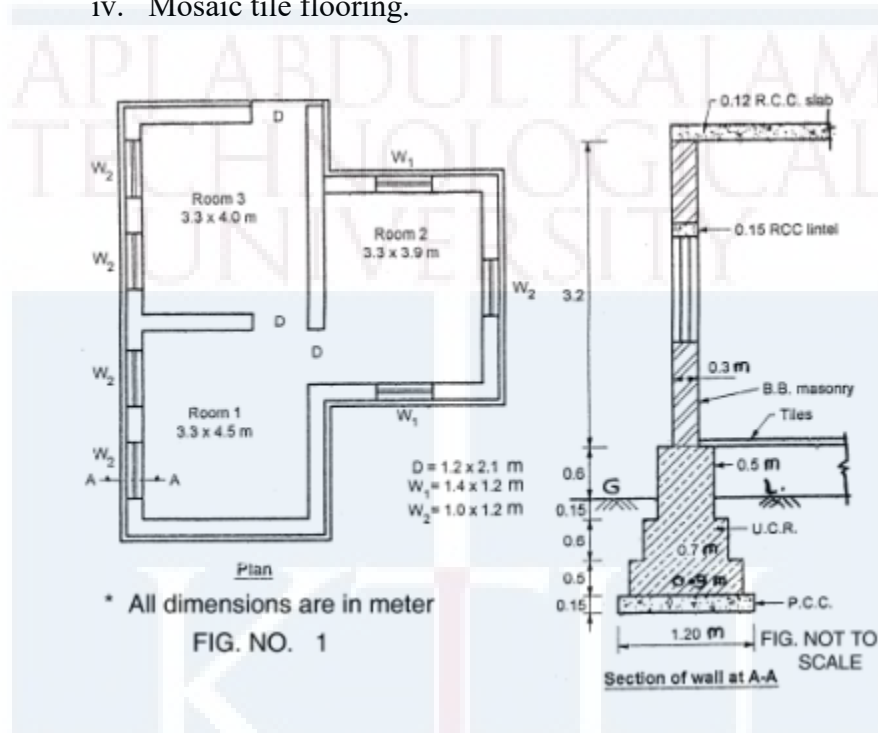
OR

7. Prepare the detailed estimate of following items of septic tank shown below (22 marks)

   a)      Earth work in excavation
   b)      Cement concrete 1:2:4
   c)      R.C.C work 1:1 ½:3
   d)      Plastering in C.M 1:3
   e)      Brick masonry

Ø 100
PIPE

INLET
OUTLET

L
B

X
X

BRICK WALL IN
CEMENT MORTAR

SECTIONAL PLAN Z Z

Ø 50 min
VENTILATING PIPE

CONCRETE ROOF OR REMOVABLE
PRECAST CONCRETE SLABS

Z   G L
Z

300
TWL

300
D/3
APPROX

D

12 mm THICK CEMENT
MORTAR FINISH

CEMENT CONCRETE
1: 2: 4

SECTION X X

## Module IV

8. a) A concrete mixer was purchased at ₹.8000/-. Assuming salvage value to be ₹.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 ₹.1,20,000/- 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%? (8 marks)

OR

9. a) A property consists of a south facing plot of land, having south-east and north sides in due directions, which measures 60m, 180m and 80m respectively. It consists of an old two storied building, having a total cubical content of 2840 cubic metres. Assuming prime cost of construction of the building as ₹.20000/- per cubic metre and allowing 10% old materials value only for the building, what would you recommend as the fair value of the property, if the front belt land (depth of front belt being 25m) be estimated at ₹.9000/- per sqm? (8 marks)

b) The owner of a building gets a net annual rent of ₹.85,500. The future life of building is estimated to be 12 years. But if recommended repairs are carried out immediately at an estimated cost of ₹.3, 00,000, it is expected to last for at least 30years. Assuming rate of interest as 8%, determine whether it is economical to carry out the recommended repairs to the building or leave it as it is. (8 marks)

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

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

**Prerequisite :** CET283 Introduction to Geotechnical Engineering

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

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

**Mapping of course outcomes with program outcomes (Minimum requirement)**

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

**Assessment Pattern**

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

**Mark Distribution**

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

**Continuous Internal Evaluation (CIE) Pattern :**

Attendance                                                       : 10 Marks

Continuous Assessment Test (2 numbers)          : 25 Marks

Assignment/Quiz/Course project                       : 15 Marks

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

**Course Level Assessment Questions**

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

Course Outcome 1 (CO1):

1. Understand Soil Investigation and Soil Exploration methods

Course Outcome 2 (CO2):

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

Course Outcome 3 (CO3):

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

Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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

| Module 1 |
| --- |
| **Site investigation and soil exploration**: Introduction and practical importance – objectivesPlanning of a sub-surface exploration program – Reconnaissance – Preliminary investigation - Detailed investigation - methods of subsurface exploration – direct methods - Open pits and trenches - Semi direct methods – Borings - Auger boring – Shell and Auger Boring - Wash boring, percussion drilling and rotary drilling – advantages and disadvantages -Guidelines for choosing spacing and depth of borings [I.S. guidelines only] - Sampling - disturbed samples, undisturbed samples and chunk samples - Types of samplers – Split spoon sampler – Thin-walled sampler – Piston sampler - Rotary sampler – Core Recovery and Rock Quality Designation |

| Module 2 |
| --- |
| Sounding and Penetration Tests - Standard Penetration Test – Procedure - Corrections to be applied to observed N values – Numerical examples - Factors influencing the SPT results and precautions to obtain reliable results – Merits and drawbacks of the test - Correlations of N value with various engineering and index properties of soils - Static Cone Penetration Test (SCPT) and Dynamic Cone Penetration Test  (DCPT) – Brief Procedure - Merits/drawbacks - Boring log - soil profile- Location of Water table - Geophysical methods : Seismic Refraction method and Electrical Resistivity method – Brief Procedure - Merits/drawbacks |

| Module 3 |
| --- |
| Ground Improvement Techniques : Introduction – Objectives - Soil improvement without the addition of any material : Shallow and Deep Compaction - Shallow compaction – Rollers - Deep Compaction - Dynamic compaction - Compaction piles - Blasting technique - Vibro compaction– Vibroflotation - Terra probe method - Vibro replacement - sand piles and stone columns - Preloading techniques – sand drains |

| Module 4 |
| --- |
| Soil improvement by adding materials : Grouting – materials - Grouting systems : One shot and two shot systems - Modes of grouting - Main types of grouting : Permeation Grouting, Compaction Grouting and Jet Grouting – Practical Applications - Grouting Plant and equipment - Grouted columns – Curtain and blanket grouting  – Practical applications - Lime stabilization –Mechanism- optimum lime content-lime fixation point |

| Module 5 |
| --- |
| Soil improvement using Geosynthetics : Materials of Geosynthetics - Types of Geosynthetics - Types of Geotextiles and Geogrids - Functions of Geosynthetics - Practical applications - Introduction to reinforced earth – principles – reinforcing materials - Reinforced earth retaining walls – components – construction sequence – practical applications - Gabions – Introduction - practical applications - Soil Nailing – Introduction – practical applications |

**Text Books:**

1. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.

2. Purushotham S. Raju, Ground Improvement Technique, Laxmi Publications

**References**:

1. Shashi K. Gulhati and Manoj Dutta, Geotechnical Engineering, Tata McGraw-Hill Publishing CompayLimited,New Delhi, 2008

2. Venkatramaiah, Geotechnical Engg, Universities Press, 2000.

3. Arora K. R., Geotechnical Engineering, Standard Publishers, 2006.

4. Moseley, Text Book on Ground Improvement, Blackie Academic Professional, Chapman & Hall, 2004

5. Boweven R., Grouting in Engineering Practice, Applied Science Publishers Ltd

6. Sivakumar Babu, G. L., An introduction to Soil Reinforcement and Geosynthetics, Universities Press (India) Private Limited, 2006

7. Jewell R.A., Soil Reinforcement with Geotextiles, CIRIA Special Publication, Thomas Telford

8. Donald .H. Gray & Robbin B. Sotir, Bio Technical & Soil Engineering Slope Stabilization, John Wiley

9. Rao G.V. & Rao G.V.S., Engineering with Geotextiles, Tata McGraw Hill

10. Korener, Construction & Geotechnical Methods In Foundation Engineering, McGraw Hill

**Course Contents and Lecture Schedule:**

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

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

**Model Question Paper**

QP CODE:

Reg No.:_____          Name:_____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

**Course Code:   CET 384**
**Course Name : GEOTECHNICAL INVESTIGATION & GROUND IMPROVEMENT TECHNIQUES**

Max. Marks: 100                                            Duration: 3 hours

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

1. Explain Objectives of soil exploration

2. List out the factors, which affect the spacing between the bore holes

3. Discuss the merits and demerits of SPT in the sub-surface investigation

4. Discuss any one method of determining the ground water table.

5. Explain Compaction piles in sand

6. Explain Significant depth of influence in Deep compaction.

7. Explain One Shot system and two shot system in grouting

8. Explain optimum lime content and lime fixation point

9. Differentiate between Woven and Non-woven geotextiles.

10. Explain the principle of reinforced earth.

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

**Module – 1**

11. (a)  Give guidelines, which enable the determination of the depth of exploration      (5 Marks)

    (b)  Explain Wash boring methods of site exploration with neat sketch. What are the advantages and disadvantages of this method.      (9 Marks)

12. (a)  Distinguish between thin-wall and thick-wall samplers      (5 Marks)

    (b)  Explain Auger boring and Shell & Auger boring methods of site exploration with neat sketches. What are the advantages of these methods.      (9 Marks)

**Module – 2**

13. (a)  Explain Static Cone Penetration Test.      (5 Marks)

    (b)  What is Standard Penetration Test? Explain the test setup and the procedure of conducting the test. What are the corrections to the observed SPT (N) value?      (9 Marks)

14. (a)  Explain Dynamic Cone Penetration Test.      (5 Marks)
    (b)  Explain Seismic Refraction Method of exploration. What are its limitations?      (9 Marks)

**Module – 3**

15. (a) Explain the dynamic compaction process for granular soils. (7 Marks)

(b) Explain Vibroflotation with neat sketch. What are the practical applications? (7 Marks)

16. (a) Explain Sand Piles and Stone Columns. (7 Marks)

(b) Explain Preloading Techniques with neat sketch. What are the advantages and disadvantages?
(7 Marks)

**Module – 4**

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

(b) Explain jet grouting method. What are its practical applications? (9 Marks)

**Module – 5**

19. (a) What are the functions of geosynthetics? (5 Marks)

(b) Explain Gabions and Soil Nailing. What are its practical applications? (9 Marks)

20. (a) List different types of geosynthetics. (5 Marks)

(b) Explain the components of Reinforced Earth Retaining Walls with neat sketch. What are the practical applications of reinforced earth? (9 Marks)
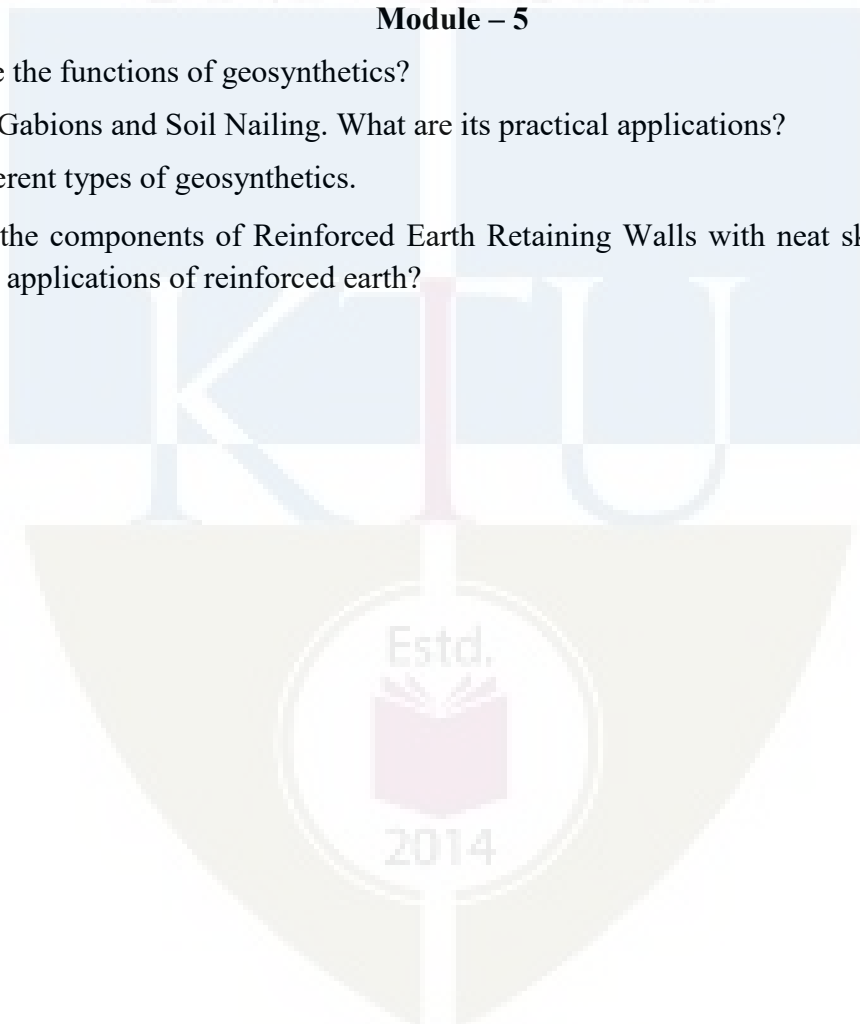
| CET 386 | ENVIRONMENTAL HEALTH AND SAFETY | CATEGORY | L | T | P | CREDIT | Year of Introduction |
|---------|--------------------------------|----------|---|---|---|--------|----------------------|
|         |                                | VAC      | 3 | 1 | 0 | 3      | 2019                 |

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

**Pre-requisite:** Nil

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

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

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

**Assessment pattern**

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

**Continuous Internal Evaluation Pattern:**

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

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

**Course Level Assessment**

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

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

**Model Question Paper**

Reg.No.:…………………..                                    QP CODE:………………..

Name:………………………

# APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

## SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

**Course Code: CET 386**

**Environment Health and Safety**

Max. Marks: 100                                                         Duration: 3 hours

### Part A

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

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

### Part B

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

### Module  I

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

OR

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

   (i) Silicosis

   (ii) Asbestosis

   (iii) Anthracosis

   (iv) Anthrax.

### Module  II

13. (a) Write briefly about the classification of biohazardous agents.(7 Marks)

    (b) What are the precautionary measures for chemical hazards? (7 Marks)

OR

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

## Module III

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

OR

16.  (a) What are the requirements for safe work platform?    (7 Marks)

    (b) Discuss about the scaffolding inspections.(7 Marks)

## Module IV

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

OR

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

## Module V

19.  (a) What are the important points in carrying outworkplace inspection?(7 Marks)

(b) What is First aid? Explain CPR. (7 Marks)

OR

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

(b) Briefly explain the elementary first aid    (4 Marks)

**Course Code: CET 386**
**Environmental Health And Safety**

## Module I

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

## Module II

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

## Module III

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

## Module IV

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

## Module V

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

**Text Books:**

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

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

**References:**

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

# Course Code: CET 386
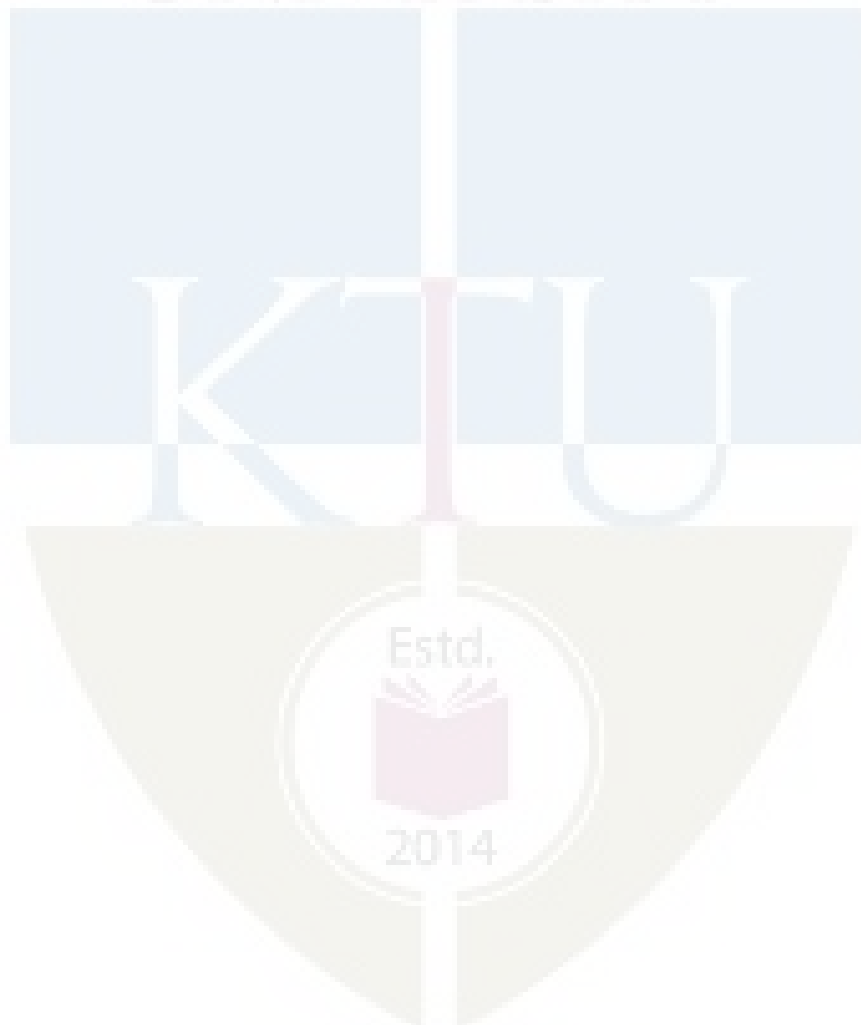
## Environmental Health And Safety

## Course content and Schedule of Lecture (sample)

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

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

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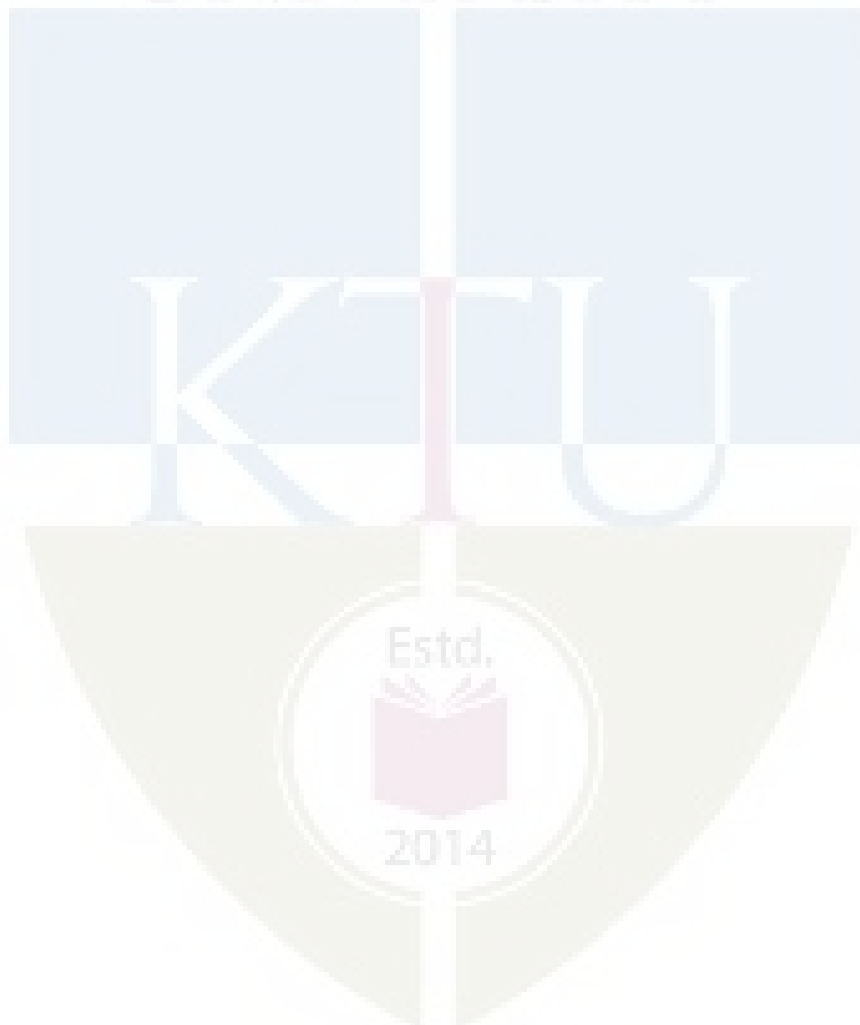
# SEMESTER VI

## HONOURS

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

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

**Prerequisite:** 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. <br> (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 − x². 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: <br> (a) the y-coordinate at P <br> (b) N1 and N3 at P. <br><br>  |
| 5. | Get the explicit shape functions for the rectangular element shown in Figure 3, using Lagrange formulae. <br><br>  |

| 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: <br> $(a)$ $I = \int\limits_{0.2}^{0.8} e^{-2x} \tan x\, dx$    $(b)$ $I = \int\limits_{-2}^{2} \dfrac{dx}{1 + x^2}$ <br> $(c)$ $I = \int\limits_{-1}^{1}\int\limits_{-1}^{1} (t^3 + s^2)\, ds\, dt$    $(d)$ $I = \int\limits_{-1}^{1}\int\limits_{-1}^{1} x \sin(x + y^2)\, dx\, dy$ |
| 2. | What are the essential features of numerical integration using Gauss quadrature? |
| 3. | Obtain the two-point Gauss quadrature points and weights from first principles |
| 4. | How to determine the number of Gauss points to evaluate an integral exactly? |
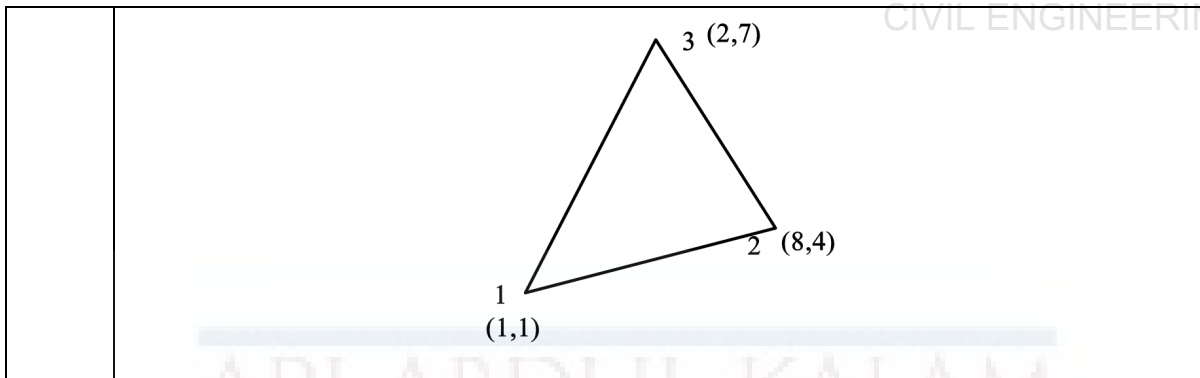
**MODULE I** – 9 hrs.
**Introduction** - Boundary value problems; Introduction to approximate numerical solutions for solving differential equations.

**MODULE II** – 9 hrs.
**Formulation techniques:** Element equations using variational approach- Element equations using weighted residual approach - the axial element example.

**MODULE III** – 9 hrs.
**Basic elements:** Interpolation and shape functions – convergence requirements; CST, LST, bilinear rectangular elements, solid elements.

**MODULE IV** – 9 hrs.
**Isoparametric Formulation:** coordinate mapping - One dimensional bar element; Two dimensional isoparametric elements - CST, LST, bilinear quadrilateral elements - Plain stress, plain strain problems.

**MODULE V**– 9 hrs.
Development of stiffness matrix for *beam elements*; Introduction to *higher order* elements; Introduction to *axisymmetric* elements.
**Numerical Integration:** Gauss quadrature

**Text Books:**
1. Desai, C.S., Elementary Finite Element Method, Prentice Hall of India.
2. Chandrupatla, T.R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India.
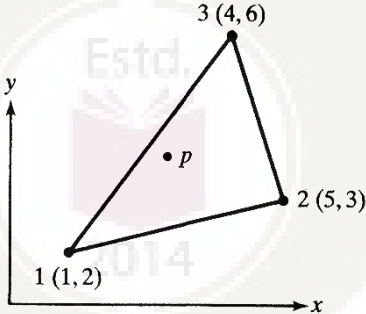
**References:**
1. Cook, R.D., et al, Concepts and Applications of Finite Element Analysis, John Wiley.
2. Bathe, K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall of India.
3. Gallaghar, R.H., Finite Element Analysis: Fundamentals, Prentice Hall Inc.
4. Rajasekaran, S., Finite Element 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

| 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**
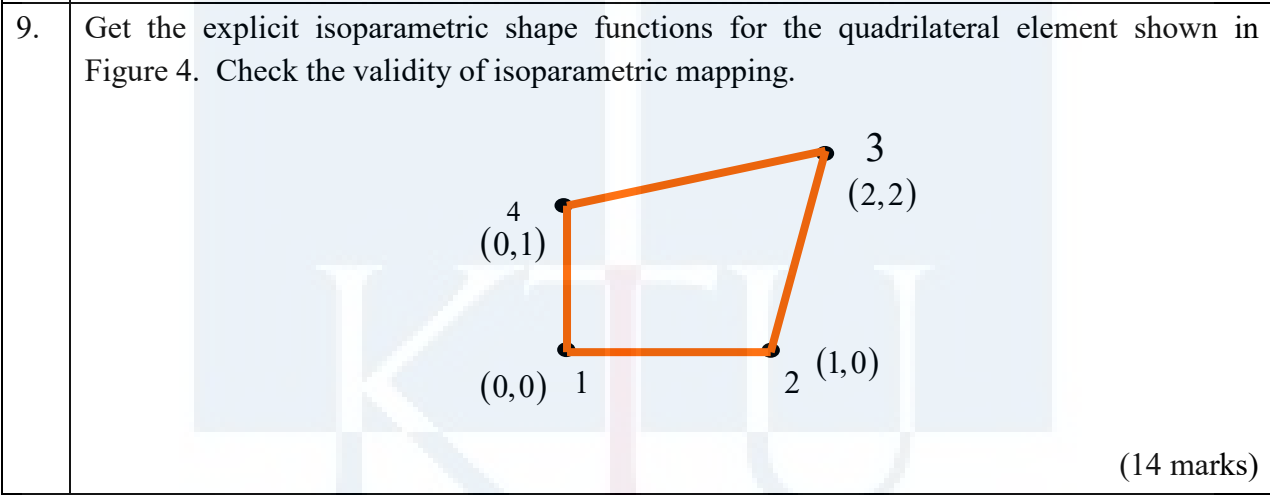
| | |
|---|---|
| Reg.No.:_____ | Name:_____ |

<div align="center">

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

**Course Code: CET394**

**Course Name: FINITE ELEMENT METHODS**

</div>

| | |
|---|---|
| Max. Marks: 100 | Duration: 3 Hours |

<div align="center">

**PART A**

*Answer all questions; each question carries 3 marks.*

</div>

| | | |
|---|---|---|
| 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? |

<div align="right">(10×3 marks = 30 marks)</div>

<div align="center">

**PART B**

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

**Module I**

</div>

| | |
|---|---|
| 2. | Using the Galerkin method obtain an approximate solution to the following boundary value problem.<br><br>$$u''(x) + u(x) + x = 0 \quad 0 < x < 1$$<br>$$u(0) = 0 \qquad u(1) = 0$$<br><br>(a) Assume a quadratic polynomial as a trial solution.<br>(b) Assume a cubic polynomial as a trial solution.<br><div align="right">(2×7=14 marks)</div> |
| 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 − x². 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.

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

$$u(1)=1 \qquad\qquad \frac{du(3)}{dx}-2u(3)=2$$

(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.
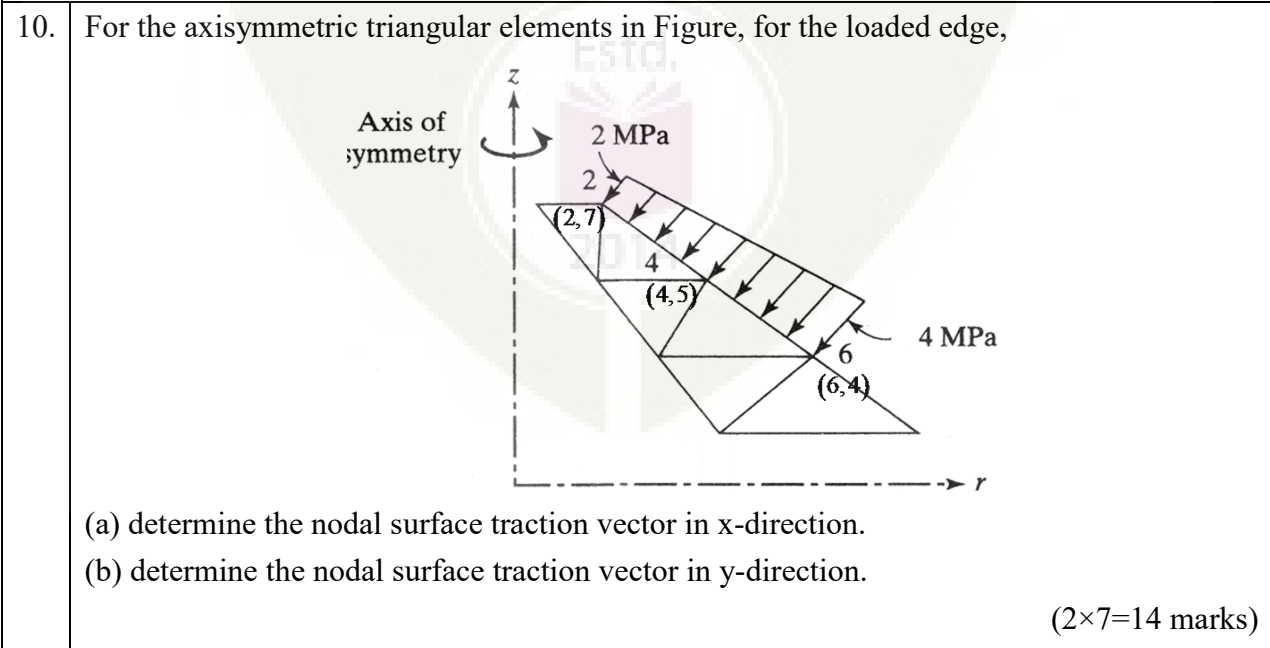
(0,0) node 1, (3,0) node 2, (3,2) node 3, node 4
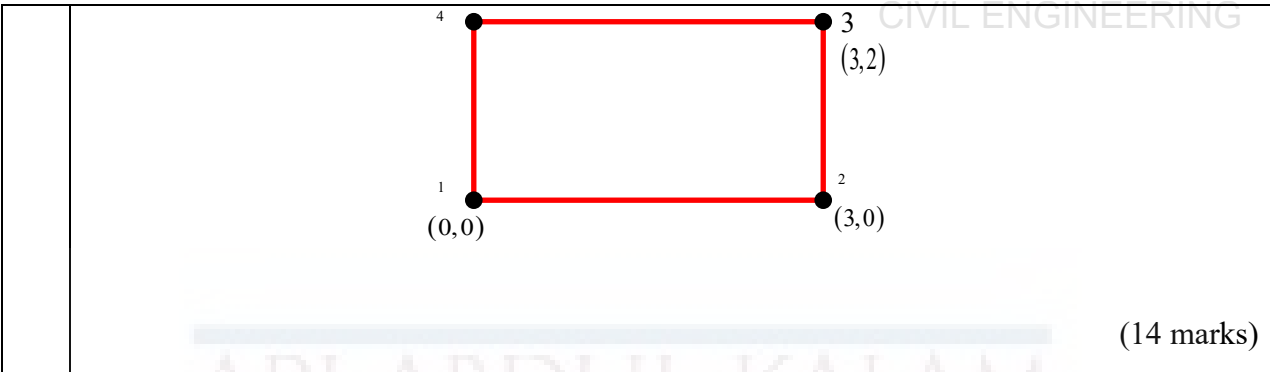
(14 marks)

## Module IV

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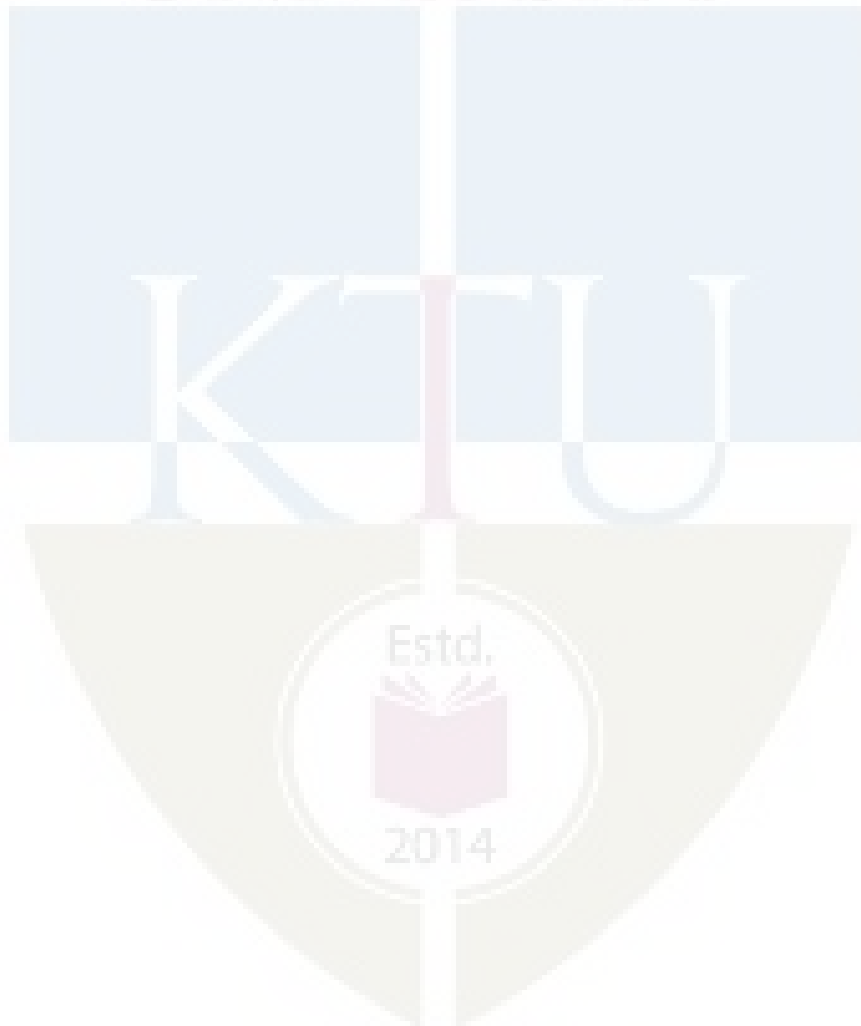
(14 marks)

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: |
|---|---|
| | $(a)\ I = \int\limits_{1}^{2}\int\limits_{4}^{6} xy\, e^{(x^2+y^2)}\,dx\,dy$   $(b)\ I = \int\limits_{-2}^{2} \frac{dx}{1+x^2}$ |
| | (2×7=14 marks) |
| | ********* |

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

## Course Contents and Lecture Schedule:

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

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

| 4 | **Module 4** | | 9 |
|---|---|---|---|
| 4.1 | Graphical methods of earth pressure computation – trial wedge method for coulomb's and Rankine's conditions, for regular and irregular ground and wall conditions -Rebhan's construction for active pressure | CO 3, CO 4 | 2 |
| 4.2 | Friction circle method - Logarithmic spiral method | CO 3 | 2 |
| 4.3 | Design of gravity retaining wall – cantilever retaining walls - Numerical Problems | CO 5 | 3 |
| 4.4 | Flexible retaining structure – type and methods of construction – design strength parameters | CO 3 | 2 |

| 5 | **Module 5** | | 9 |
|---|---|---|---|
| 5.1 | Safety factor for sheet pile walls – Computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – Numerical Problems | CO3, CO 4 | 2 |
| 5.2 | Anchored sheet piles – free earth method – fixed earth method – Rowe's moment reduction method | CO 3, CO 4 | 2 |
| 5.3 | Stability of sheet piling | CO 3, CO 5 | 1 |
| 5.4 | Diaphragm walls and coffer dams – type of diaphragm walls and their construction techniques in various soil types | CO 3 | 2 |
| 5.5 | Earth pressure on braced cuts and coffer dams – Design of coffer dams | CO 3, CO 5 | 2 |

### 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 : $\gamma$= 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)
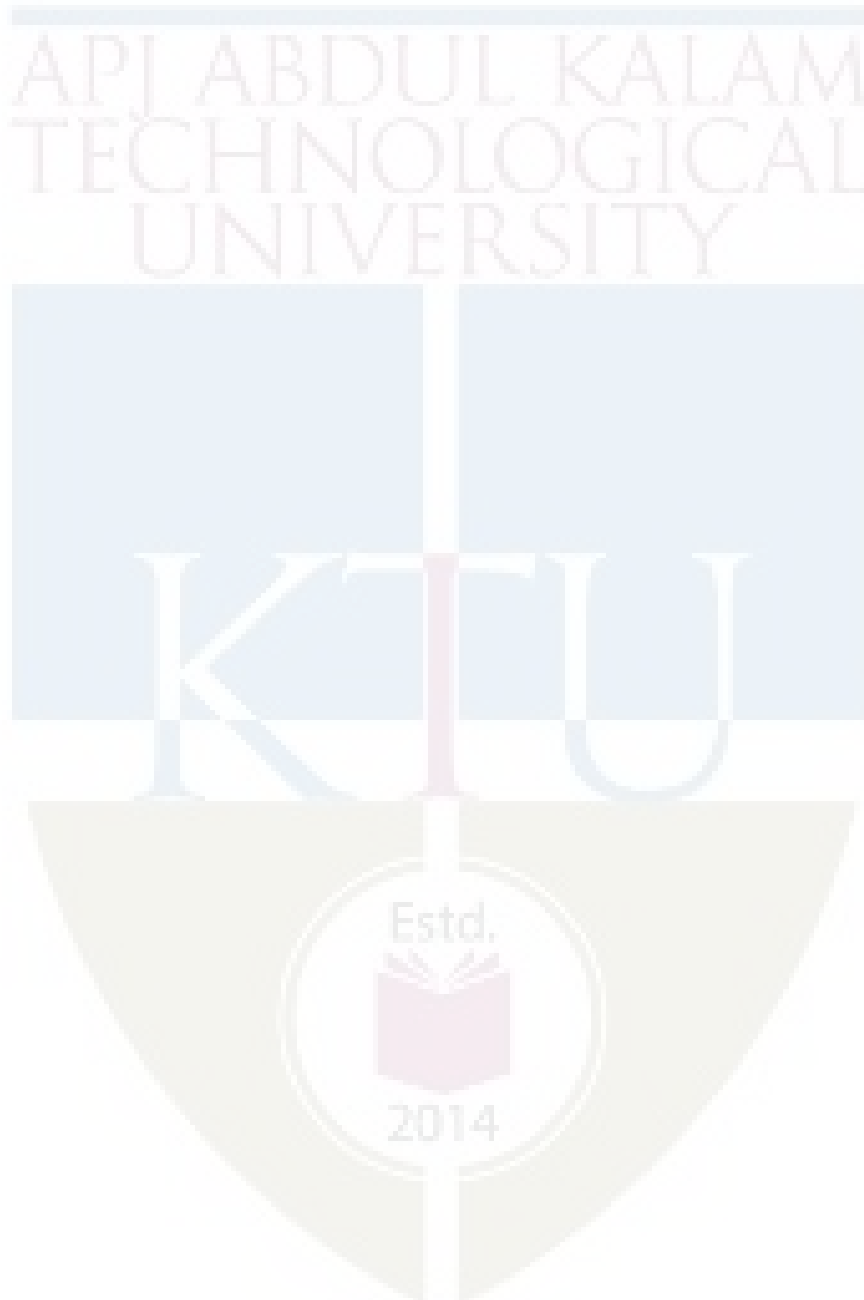
| CET 398 | ENVIRONMENTAL POLLUTION MODELLING | CATEGORY | L | T | P | CREDIT | Year of Introduction |
|---------|-----------------------------------|----------|---|---|---|--------|----------------------|
|         |                                   | VAC      | 3 | 1 | 0 | 4      | 2019                 |

**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:**

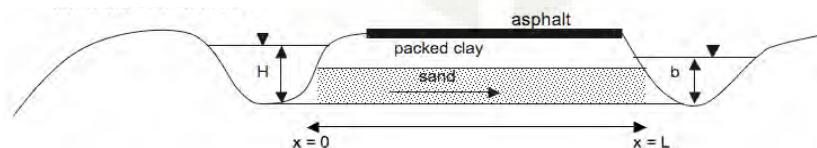Attendance                                              : 10 marks
Continuous Assessment Test (2 numbers)     : 25 marks
Assignment/Quiz/Course project                 : 15 marks

**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 $\sigma y= 80m$ and $\sigma z= 120m$. |
|---|---|
| 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

ation station when the wind is from $30\,^\circ$ at 3 m/s. Given that

matter concentration at the sampling station when the wind is from $30\,^\circ$ 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)