| CET401 | DESIGN OF STEEL STRUCTURES | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 | 2019 |

**Preamble**: Goal of this course is to expose the students to the fundamental concepts of DESIGN OF STEEL STRUCTURES. After this course, students will be able to design steel structures and to recognize practical problems in real-world situations and respond accordingly.

**Prerequisite:** CE302 STRUCTURAL ANALYSIS II

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

| Course Outcome | Description of Course Outcome | Prescribed learning level |
|---|---|---|
| CO 1 | Explain the behavior and properties of structural steel members to resist various structural forces and actions and apply the relevant codes of practice | Understanding and analyzing |
| CO 2 | Analyses the behavior of structural steel members and undertake design at both serviceability and ultimate limit states | Analysing and applying |
| CO 3 | Explain the theoretical and practical aspects of Design of composite Steel Structure along with the planning and design aspects | Understanding and applying |
| CO 4 | Apply a diverse knowledge of Design of Steel engineering practices applied to real life problems | Applying |
| CO5 | Demonstrate experience in the implementation of design of structures on engineering concepts which are applied in field Structural Engineering | Applying |

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

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

**Assessment Pattern**

| Bloom's Category | Continuous Assessment Tests | | End Semester Examination (Marks) |
|---|---|---|---|
| | Test 1 (Marks) | Test 2 (Marks) | |
| Remember | | | |
| Understand | 25 | 10 | 20 |
| Apply | | 40 | 50 |
| Analyse | 25 | | 30 |
| 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): Explain the behavior and properties of structural steel members to resist various structural forces and actions and apply the relevant codes of practice**

1. The fundamental concepts of basic structural behavior in steel structures
2. Basic theories of steel structural members and its analysis.

**Course Outcome 2 (CO2): Analyses the behavior of structural steel members and undertake design at both serviceability and ultimate limit states**

1. The fundamental concepts of different structural members
2. Design of simple structural members

**Course Outcome 3 (CO3): Explain the theoretical and practical aspects of Design of composite Steel Structure along with the planning and design aspects**

Design of composite beams and columns

**Course Outcome 4 (CO4): Apply a diverse knowledge of Design of Steel engineering practices applied to real life problems**

Design of different structural elements considering application aspects

**Course Outcome 5 (CO5): Demonstrate experience in the implementation of Design of Structures on engineering concepts which are applied in field Structural Engineering**

1. Design engineering problems giving importance to field application

**Syllabus**

| Module | Contents |
|---|---|
| 1 | Introduction to steel and steel structures, properties of steel, structural steel sections. Introduction to design: Design loads and load combinations, limit state design concepts. Connections bolted and welded ( direct loads) |
| 2 | Tension members-Types of sections – net area- design of tension members- concept of shear lag-use of lug angle-connections in tension members |
| 3 | Compression members- design of struts- solid and built up columns for axial loads--design of lacings and battens-column bases- slab base – gusseted base |
| 4 | Design of beams- laterally restrained and unrestrained – simple and compound beams-plate girders subjected to uniformly distributed loads – design of stiffeners. |
| 5 | Design of roof trusses- types-design loads and load combinations- assessment of wind loads- design of purlins. Moment resistant/Eccentric connections (in plane and out of plane)<br>Fire resistant design-criterion-fire resistance assessment-material property-design approach-passive protection for steel work-fire resistant steel-fire performance assessment |

**Text Books:**

1. Punmia B. C., Jain A. K. and Jain A. K., Design of Steel Structures, Laxmi Publications (P) Ltd, 2017

2. Ramchandra S and Virendra Gehlot, Design of Steel Structures Vol. II, Standard Book House, 2007

**References**:

1. N.Subramanian; Steel Structures, Oxford Publication
2. P. Dayaratnam., Design of Steel Structures ,Wheeler Publishing, 2003
3. Raghupathi, Steel Structures, Tata McGraw Hill, 2006
4. V L Shah & Veena Gore, Limit State Design of steel Structures , Structures Publications, 2009
5. William T Segui., Steel Design , Cenage Learning, 6e, 2017
6. IS 800 – 2007, Code of practice for Structural steel design, BIS
7. IS:875-Part 3-2015 Design loads for buildings Part 3: Wind loads , BIS

**Model Question Paper**

**QP CODE:**

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

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

**Course Code: CET401**

**Course Name: DESIGN OF STEEL STRUCTURES**

**(Use of Codes IS 800, IS 875, IS 883 is permitted. Assume suitable data wherever necessary)**

Max. Marks: 100 Duration: 3 hours

**Part A**

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

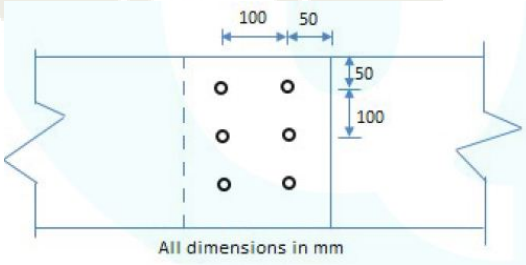
1. Explain the failures of bolted joints.
2. What do you mean by prying forces?
3. Under what circumstances do we use slot welds and plug welds?
4. With the help of suitable diagram, explain the concept of shear lag
5. What are the main purposes of lacings and battens?
6. Explain the failure modes of axially loaded columns
7. Distinguish between laterally restrained and unrestrained beams.
8. What is lateral torsional buckling of beams?
9. List the different fire resistance criterion.
10. List the various passive protection methods for steel structures against fire.

**Part B**

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

**Module – 1**

11. Determine the strength and efficiency of a bolted lap joint shown I the figure. The bolts are of 20mm diameter, grade 4:6. The plates are of 12mm thick and grade F2410



12. An ISMC 250 @ 298kg/m is used as a tie member to transmit a factored load of 800kN. The channel section is connected to a gusset plate of 10mm thickness Design a fillet weld if the lap length is limited to 300mm Provide slot welds if required.

**Module – 2**

13. Design a tension member to carry an axial factored load of 500kN Use a double angle rolled steel section connected (at site) to each side of a gusset plate of10mm thick using 20mm diameter bolts of grade 4.6.
14. A tie member consisting of an angle section ISA100x75x8 designed to transfer a factored axial load of 280kN, is to be welded to a gusset plate of 10mm thick using 6mm fillet weld. Design the weld if the weld is provided on three sides by overlapping the angle on the gusset plate at a shop. Also sketch the connection showing the weld lengths.

**Module – 3**

15. Determine the design compressive load capacity of a column. made of a rolled steel section ISMC 200 @217N/m if length of the column is 3m, with both ends fixed.
16. Design a column 10 m long to carry a factored axial load of 1100kN The column is restrained in position but not in direction at both ends. Design a batten system for the column Assume that the two channels are kept back to back

**Module – 4**

17. Design a simply supported beam of 10m effective span carrying a total factored load of 60kN/m. The depth of beam should not exceed 500mm. The compression flange of beam is laterally supported by floor construction. Assume stiff end bearing is 75mm
18. A conference hall 8mx12m is provided with a 120 mm RCC slab over rolled steel I beams spaced 4m centre-to-centre. The super imposed load is 4kN/m2 and floor finish of 1.5 kN/m2. Design one of the beam as laterally supported.

**Module – 5**

19. A purlin is to be designed to support a GI sheet as roofing material for a truss spaced at 3.5m c/c. purlin along the principal rafters are arranged at a distance of 1.35mc/c. The pitch of truss is 0.2m. Design a section for the purlin. Assume basic wind speed as 44m/s
20. Explain the different fire-resistant design approaches used in steel structures.

**Course Contents and Lecture Schedule:**

| Module | Contents | Course Outcomes Addressed | Hours |
|---|---|---|---|
| **1** | **Module 1** | | **7** |
| 1.1 | Introduction to steel and steel structures | CO 1 | 1 |
| 1.2 | Properties of structural steel and types of Structural steel sections | CO 1 | 1 |
| 1.3 | Introduction to design-design philosophies- Design loads and load combinations | CO 1 | 1 |
| 1.4 | Connections: Bolted-different types-joints(lap joint, butt joint) - eccentric loaded connections-beam to beam connections | CO 1,CO2 | 2 |
| 1.5 | Connections : Welded-different types-joints(lap joint, butt joint) - eccentric loaded connections-beam to beam connections | CO1,CO 2 | 2 |
| **2** | **Module 2** | | **7** |
| 2.1 | Introduction- Types of tension members | CO 1 | 1 |
| 2.2 | Modes of failure | CO 1 | 1 |
| 2.3 | Factors affecting strength of tension members | CO 1 | 1 |
| 2.4 | Design of tension members | CO 1 ,CO2 | 1 |
| 2.5 | Concept of shear lag | CO 1 | 1 |
| 2.6 | Application of lug angle | CO1,CO 3 | 1 |
| 2.7 | Connections in tension members | CO 1 & CO 3 | 1 |
| **3** | **Module 3** | | **7** |
| 3.1 | Introduction-compression members-classification-Behavior (theory only-No equations) | CO 1 | 1 |
| 3.2 | Design of struts | CO 1,CO2 | 1 |
| 3.3 | Solid and built up columns for axial loads alone | CO1,CO2, CO 3 | 1 |
| 3.4 | Design of lacing system | CO 1,CO3 | 1 |
| 3.5 | Design of battening system | CO 1,CO3 | 1 |
| 3.6 | Column base plate introduction- Simple slab base plate-only axial | CO 1,CO2 | 1 |

| | | | |
|---|---|---|---|
| | load | | |
| 3.7 | Gusseted base-only axial load | CO1,CO2, CO 4 | 1 |
| **4** | **Module 4** | | **7** |
| 4.1 | Introduction- Beams, design of Laterally restrained beams | CO 1 | 1 |
| 4.2 | Laterally Unrestrained beams | CO 1 | 1 |
| 4.3 | Design of simple beams | CO 1,CO2 | 1 |
| 4.4 | Design of compound beams | CO 1,CO3 | 1 |
| 4.5 | Plate girder design for welded connection | CO 1,CO2 | 1 |
| 4.6 | Design of stiffeners-end bearing and intermediate stiffeners | CO2,CO 4 | 1 |
| 4.7 | Gantry girders AND beam-column (introduction only-No design) | CO 1 & CO 4 | 1 |
| **5** | **Module 5** | | **7** |
| 5.1 | Type of roof truss-design loads and load combinations | CO 1 | 1 |
| 5.2 | Calculation of wind loads | CO 1 & CO 4 | 1 |
| 5.3 | Design of purlins | CO 1, CO2 | 1 |
| 5.4 | Moment resistant and eccentric connections-in plane and out of plane-(No design) | CO 1 | 1 |
| 5.5 | Introduction –Fire resistance criterion | CO 1 | 1 |
| 5.6 | Fire resistance assessment of steel structure-material property at elevated temperature-design approaches and tools-different models-methods-procedures | CO 1, CO2 | 1 |
| 5.7 | Passive protection-fire performance assessment | CO1, CO3 | 1 |

| CET413 | PRESTRESSED CONCRETE | 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 the fundamental concepts of prestressed concrete as well as the analysis and design of various prestressed concrete elements using IS Code provisions

**Pre-requisite:** Structural analysis, Design of reinforced concrete structures

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

| Course Outcome | Description | Prescribed learning level |
|---|---|---|
| CO1 | Explain the concepts of prestressing and analyze prestressed concrete members for stresses and losses. | Analyze |
| CO2 | Analyze for flexure, shear and torsional resistance of PSC members. | Analyze |
| CO3 | Design pre-tensioned and post-tensioned members symmetrical about vertical axis. | Apply/Create |
| CO4 | Analyse the deflections of prestressed concrete members. | Analyze |
| CO5 | Analyze the transfer of prestress in pretensioned members, anchorage zone stresses in post tensioned members. | Analyze |
| CO6 | Analyze prestressing of statically indeterminate structures and design continuous members. | Apply |
| CO7 | Analyze composite construction of prestressed and in situ concrete. | Apply |
| CO8 | Analyze and design PSC slabs. | Apply/ Create |

**Mapping of course outcomes with program outcomes**

| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CET413 Prestressed Concrete | CO1 | 3 | 2 | 3 | | | | | | | | | |
| | CO2 | 3 | 3 | 3 | | | | | | | | | |
| | CO3 | 3 | 3 | 3 | | | | | | | | | |
| | CO4 | 3 | 2 | 3 | | | | | | | | | |
| | CO5 | 3 | 3 | 3 | | | | | | | | | |
| | CO6 | 3 | 3 | 3 | | | | | | | | | |
| | CO7 | 3 | 2 | 3 | | | | | | | | | |
| | CO8 | 3 | 2 | 3 | | | | | | | | | |

**Assessment pattern**

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

**Continuous Internal Evaluation Pattern:**

| | | |
|---|---|---|
| Attendance | : | 10 marks |
| Continuous Assessment Test (2 numbers) | : | 25 marks |
| Assignment/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 Level Assessment (Sample) Questions**

**CO1: Explain the concepts of prestressing and analyze prestressed concrete members for stresses and losses.**

1. What are the advantages of prestressed concrete members?
2. What is the need of high strength concrete and steel?
3. Explain different prestressing systems with figures.
4. What do you mean by stress concept while analyzing prestressed systems?
5. Explain the load balancing concept for extreme fiber stresses for parabolic tendon profile.
6. Explain the losses of prestress in prestressed concrete
7. A rectangular concrete beam, 100 mm wide by 250 mm deep spanning over 8 m is prestressed by a straight cable carrying an effective prestressing force of 250 kN located at an eccentricity of 40 mm. The beam supports a live load of 1.2 kN/m. Calculate the resultant stress distributing for the central cross section of the beam. The density of concrete is 24 $kN/m^3$.

**CO2: Analyze for flexure, shear and torsional resistance of PSC members.**

1. A concrete beam of rectangular section, 300 mm wide and 800 mm deep is subjected to a twisting moment of 30 kNm and a prestressing force of 150 kN acting at an eccentricity of 220 mm. Calculate the maximum principal tensile stress. If the beam is subjected to a bending moment of 100 kNm in addition to the twisting moment, calculate the maximum principal tensile stress.
2. Explain with neat sketches the types of shear cracks in structural concrete members.
3. A concrete beam of rectangular section, 300 mm wide and 800 mm deep is subjected to a twisting moment of 30 kNm and a prestressing force of 150 kN acting at an eccentricity of 220 mm. i) Calculate the maximum principal tensile stress. ii) If the beam is subjected to a maximum bending moment of 100 kNm in addition to the twisting moment, calculate the maximum principal tensile stress

**CO3: Design pre-tensioned and post-tensioned members symmetrical about vertical axis**.

1. A post tenstioned prestressed concrete beam for the roof of an industrial structure has a simply supported span of 25 m. The beam has to support a dead load of 2 kN/m together with an imposed load of 15 kN/m in addition to the self-weight. The grade of concrete is M40 and the compressive strength of concrete at transfer is 35 $N/mm^2$. The loss ratio is 0.80. The 64 mm cables containing 7-15 mm strands with an ultimate load capacity of 1750 kN are available. Use IS 1343 provisions, design the cross section of the girder to comply with various limit states. Sketch the details of cables in the cross-section and the profile of cables along the depth and length of the beam.
2. A prestressed concrete beam of rectangular cross-section is subjected to an effective prestressing force of 500 kN provided by 5 numbers of 12.5 mm diameter strands of cross-sectional area 506 $mm^2$. The cross-sectional dimension of the beam is 450 mm × 600 mm. The eccentricity of the posttensioned tendon is 150 mm. A service load Bending Moment of 176 kNm, Torsional Moment of 56 kNm and Shear Force of 75kN are acting at the section of the beam. Take the cube strength of concrete as 40$N/mm^2$ and the ultimate tensile strength of tendons as 1820 $N/mm^2$. Using IS 1343 codal provisions design the longitudinal and transverse reinforcements of the beam.

**CO4: Analyse the deflections of prestressed concrete members.**

1. A prestressed concrete beam spanning over 8 m is of rectangular section, 150 mm wide and 300 mm deep. The beam is prestressed by a parabolic cable having an eccentricity of 75 mm below the centroidal axis at the centre of span and an eccentricity of 25 mm above the centroidal axis at the support sections. The initial force in the cable is 350 kN. The beam supports 3 concentrated loads of 10 kN each at intervals of 2m. Assume any missing values. a) Neglecting losses of prestress, estimate the short-term deflection due to (Prestress + self-weight) and b) Allowing for 20 percent loss in prestress, estimate the

long-term deflection under (prestress + self-weight +live load) assuming creep coefficient at 1.80.

2. A PSC beam of breadth 240 mm and depth 300 mm is S.S. on an effective span of 6 m. It is prestressed by parabolic cable with an eccentricity of 75mm below the centroid at the mid span section and 45 mm above centroid at the support section. Prestressing force is 480 kN. Calculate the initial mid-span deflection. Assume the unit weight of concrete as 25 $kN/m^2$ and modulus of elasticity of concrete as 2.5 x $10^4$ MPa.
3. A PSC beam of span 8m has the following data: Area =32×103 $mm^2$, E=38 $kN/m^2$, width of gyration 72 mm Cable: parabolic, 6 wires of 7 mm HTS, concentric at supports and eccentric by 50mm at mid span. Fpe= 1000 N/mm2 Determine the deflection for the following cases: i) Self-weight+ Prestress ii) Self-weight +Prestress +Live load of 3 kN/m.

**CO5: Analyze the transfer of prestress in pretensioned members, anchorage zone stresses in post tensioned members**.

1. Explain the process of transferring of prestress in pretensioned members.
2. What are anchorage zones in post tensioned member?
3. What do you mean by bursting force?
4. Explain the end block designing.
5. Design the bearing plate and the end zone reinforcement for the following bonded post-tensioned beam. The strength of concrete at transfer is 50 MPa. A pre-stressing force of 1055 kN is applied by a single tendon. There is no eccentricity of the tendon at the ends.

**CO6: Analyze prestressing of statically indeterminate structures and design continuous members.**

1. What are the advantages of using continuous members in prestressed concrete structures?
2. Distinguish between primary moment and secondary moment in the context of prestressing of statically indeterminate structures.
3. A two-span continuous beam ABC (AB=BC=10 m) is of rectangular section 200 mm wide and 500 mm deep. The beam is prestressed by a parabolic cable, concentric at end supports and having an eccentricity of 100 mm towards the soffit of the ebam at centre of spans and 200 mm towards the top of beam at mid support B. The effective force in the cable is 500 kN. a) Show that the cable is concordant. b) Locate the pressure line in the beam when it supports an imposed load of 5.6 kN/m in addition to its self-weight.

**CO7: Analyze composite construction of prestressed and in situ concrete.**

1. What are the advantages of using precast prestressed units in association with the in-situ concrete?
2. Distinguish between propped and unpropped construction methods in composite construction using stress diagrams at various stages of construction.
3. A rectangular pretensioned concrete beam has a breadth of 100 mm and depth 230 mm and the prestress after all losses have occurred is 12 N/sq.mm at the soffit and zero at the top.

The beam is incorporated in a composite I beam by casting a top flange of breadth 300 mm and depth 50 mm. Calculate the maximum uniformly distributed live load that can be supported on a simply supported span of 4.5m, without any tensile stresses occurring, a) if the slab is externally supported while casting and b) if the pretensioned beam supports the weight of the slab while casting.

4. Specify the various steps involved in the design of composite sections.

**CO8: Analyze and design PSC slabs.**

1. What are the different types of Prestressed concrete slabs?
2. Design a post-tensioned prestressed concrete two-way slab 6 m by 8 m in size to support a live load of 3 $kN/m^2$. If cables of four wires of 5 mm diameter stressed to 1000 $n/mm^2$ are available for use, determine the number of cables in the two principal directions. The stresses in concrete not to exceed 14 $N/mm^2$ in compression and tensile stresses are not permitted under service loads. The loss ratio is 0.8. Check for the limit state of serviceability and collapse.

## Syllabus

**Module I**

Basic concept and principles of pre-stressed concrete; Prestressing: - Pre tensioning and Post tensioning, Thermo elastic and Chemical prestressing. Need of high strength concrete and steel, Advantages of prestressed concrete over reinforced concrete, Different prestressing systems; Analysis of prestress and bending stress: - Stress concept, Strength concept: - Pressure line and internal resisting couple and Load balancing concept for extreme fiber stresses for various tendon profile.

**Losses of Prestress:** Stages of losses, Types of losses in pre-tensioning and post-tensioning due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction and Sudden changes in temperature; Loss of pre-stress Stresses at transfer and service loads.

**Module II**

**Flexural strength:** - Codal provision for Limit state design, Design stress strain curve for concrete. Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force, and Eccentricity. Limiting zone for prestressing force.

**Shear Resistance of PSC members:** - Shear and Principal stresses, Ultimate shear resistance of PSC members: - Section cracked and uncracked, Design for shear using IS code.

**Torsional Resistance of PSC members**: - Pure torsion, Combined bending moment and torsion, Combined bending moment, shear and torsion, Design of reinforcement using IS code provision.

**Module III**

**Design of Pretensioned and Post-Tensioned Flexural Members:**
Dimensioning of Flexural members, Estimation of Self Weight of Beams, Design of Pre tensioned and Post tensioned members symmetrical about vertical axis;
**Deflections of prestressed concrete members**: Importance, factors, short term and long term deflection. Codal provisions.

**Module IV**

**Transfer of Prestress in Pretensioned members :** Transmission length, Bond stresses, Transverse Tensile Stresses, End-Zone reinforcement, Flexural bond stresses, Code Provisions
**Anchorage zone Stresses in post tensioned members :** Stress distribution in end block, Methods of investigation, Anchorage zone reinforcements, Design (IS Code method only).

**Module V**
**Prestressing of statically indeterminate structures:** Advantages, Effect, Method of achieving continuity, Primary, Secondary and Resultant moments, Pressure line, Concept of Linear transformation, Guyon's theorem, Concordant cable profile and its determination. Design of Continuous Prestressed beams
**Composite construction of Prestressed and in situ Concrete:**
Types of composite construction, Analysis of stresses, Flexural strength.

**PSC Slabs -** Types**,** Design and analysis of PSC One-way and two way slabs.

**Text Books**

1. Krishna Raju.N,(2012) "*Prestressed Concrete*", 4th Edition, Tata McGraw Hill Publishing Co. New Delhi.
2. Dayaratnam.P.(2012), "*Prestressed Concrete*", Tata McGraw Hill Publishing Co. New Delhi
3. Sinha .N.C & S.K. Roy,(1985) "*Fundamentals of Prestressed Concrete*, S.Chand & Co.
4. Rajagopalan.N.(2010) "*Prestressed Concrete*", Narosa Publishing House, New Delhi.

**References:**

1. Lin .T.Y. (2010)"*Design of Prestressed Concrete Structures*", John Wiley and Sons - Inc
2. Leonhardt.F. (1964),"*Prestressed Concrete Design and Construction*", - Second Edition Wilhelm Ernst & Sohn, Berlin.
3. Guyon .V.(1995), "*Limit State Design of Prestressed Concrete*", - Vol - 1 & 2, Applied Science Publishers, London
4. Mallick and Rangaswamy., (2014),"*Mechanics of Prestressed Concrete Design* ", Khanna Publishers.
5. Pandit & Gupta., " *Prestressed Concrete* ", CBS Publishers

6. F.K. Hong & R.H. Evans., (2007),*"Reinforced and Prestressed Concrete* " Tata McGraw Hill Co.
7. Abeles, P. W., *"The Principles and Practice of Prestressed Concrete"*, Crosby Lockwood and Sons, 1949.
8. Collins, M. P. and Mitchell, D., "*Prestressed Concrete Structures"*, Prentice-Hall, Inc., 1991.
9. Magnel, G., "*Prestressed Concrete",* Concrete Publications, 1948.
10. Nawy, E. G., "*Prestressed Concrete – A Fundamental Approach"*, 5th Edition, Prentice-Hall, Inc., 2006.
11. Nilson, A.,"*Design of Prestressed Concrete"*, 2nd Edition, John Wiley & Sons, 1987.

**Reference codes**

Codes The codes related with prestressed concrete are listed below according to the publishing agencies.

**Bureau of Indian Standards**

IS:784 - 2001 Prestressed Concrete Pipes (Including Fittings) - Specification

IS:1343 - 1980 Code of Practice for Prestressed Concrete

IS:1678 - 1998 Specification for Prestressed Concrete Poles for Overhead Power, Traction and Telecommunication Lines

IS:1785 - 1983 Specification for Plain Hard Drawn Steel Wire for Prestressed Concrete

Part-1: Cold-drawn Stress-relieved wire

Part-2: As-drawn wire

IS: 2090 - 1983 Specification for High Tensile Steel Bars Used in Prestressed Concrete

IS:2193 - 1986 Specification for Precast Prestressed Concrete Steel Lighting Poles

IS:3370 - 1967 Code of Practice for Concrete Structures for Storage of Liquids

Part-3: Prestressed Concrete Structures

IS:6003 - 1983 Specification for Indented Wire for Prestressed Concrete

IS:6006 - 1983 Specification for Uncoated Stress Relieved Strand for Prestressed Concrete IS:6461 - 1973 Glossary of Terms Relating to Cement Concrete

Part 11: Prestressed Concrete

IS:10790 - 1984 Methods of Sampling of Steel for Prestressed and Reinforced Concrete

Part-1: Prestressing Steel

Part-2: Reinforcing Steel Prestressed Concrete Structures Dr. Amlan K Sengupta and Prof. Devdas Menon Indian Institute of Technology Madras

IS:13158 - 1991 Specification for Prestressed Concrete Circular Spun Poles for Overhead Power, Traction and Telecommunication Lines

IS: 14268 - 1995 Specification for Uncoated Stress Relieved Low Relaxation Seven Ply Strand for Prestressed Concrete

**American Concrete Institute, USA**

ACI 318M-05, Building Code Requirements for Structural Concrete and Commentary.

**British Standard Institution, UK**

BS 8110 : Part 1 : 1997, Structural Use of Concrete : Part 1 Code of Practice for Design and Construction.

**Council of Standards Australia**

AS 3600 Concrete Structures 2001.

**European Committee for Standardisation**

EN 1992 Design of Concrete Structures, 2005.

**Handbook**

PCI Design Handbook, 5th Edition published by the Precast/Prestressed Concrete Institute, USA

**Course Contents and Lecture Schedule**

| Module | Topic | Course outcome addressed | No of Hours |
|---|---|---|---|
| **Module I (7 Hours)** | | | |
| 1.1 | Basic concept and principles of pre-stressed concrete; Prestressing: - Pre tensioning and Post tensioning, Thermo elastic and Chemical prestressing. Need of high strength concrete and steel | CO1 | 1 |
| 1.2 | Advantages of prestressed concrete over reinforced concrete, Different prestressing systems | CO1 | 1 |
| 1.3 | Analysis of prestress and bending stress: - Stress concept, Strength concept: - Pressure line and internal resisting couple | CO1 | 1 |
| 1.4 | Load balancing concept for extreme fiber stresses for various tendon profile | CO1 | 1 |
| 1.5 | Losses of Prestress: Stages of losses, Types of losses in pre-tensioning and post-tensioning | CO1 | 1 |
| 1.6 | Losses due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction and Sudden changes in temperature | CO1 | 1 |

| | | | |
|---|---|---|---|
| 1.7 | Loss of pre-stress Stresses at transfer and service loads | CO1 | 1 |
| **Module II (7 Hours)** | | | |
| 2.1 | Flexural strength: - Codal provision for Limit state design, Design stress strain curve for concrete. Design of sections for flexure: - Expressions for minimum section modulus, | CO2 | 2 |
| 2.2 | Prestressing force, and Eccentricity. Limiting zone for prestressing force. | CO2 | 1 |
| 2.3 | Shear Resistance of PSC members: - Shear and Principal stresses, Ultimate shear resistance of PSC members: - Section cracked and uncracked | CO2 | 1 |
| 2.4 | Design for shear using IS code. Torsional Resistance of PSC members: - Pure torsion, Combined bending moment and torsion | CO2 | 1 |
| 2.5 | Combined bending moment, shear and torsion modes of failure | CO2 | 1 |
| 2.6 | Design of torsion reinforcement using IS code provision | CO2 | 1 |
| **Module III (7 Hours)** | | | |
| 3.1 | Design of Pretensioned and Post-Tensioned Flexural Members: Dimensioning of Flexural members, Estimation of Self Weight of Beams | CO3 | 1.5 |
| 3.2 | Design of Pre tensioned and Post tensioned members symmetrical about vertical axis | CO3 | 1.5 |
| 3.3 | Deflections of prestressed concrete members: Importance, factors | CO4 | 1 |
| 3.4 | Short term deflections | CO4 | 1.5 |
| 3.5 | Long term deflection. Codal provisions | CO4 | 1.5 |
| **Module IV (7 Hours)** | | | |
| 4.1 | Transfer of Prestress in Pretensioned members - Introduction | CO5 | 1 |
| 4.2 | Transmission length, Bond stresses | CO5 | 1 |
| 4.3 | Transverse Tensile Stresses, End-Zone reinforcement, | CO5 | 1 |
| 4.4 | Flexural bond stresses, Code Provisions | CO5 | 1 |
| 4.5 | Anchorage zone Stresses in post tensioned members : Stress distribution in end block, Methods of investigation | CO5 | 1 |

| | | | |
|---|---|---|---|
| 4.6 | Anchorage zone reinforcements, Design (IS Code method only) | CO5 | 2 |
| **Module V (7 Hours)** | | | |
| 5.1 | Prestressing of statically indeterminate structures: Advantages, Effect, Method of achieving continuity, Primary, Secondary and Resultant moments | CO6 | 1 |
| 5.2 | Pressure line, Concept of Linear transformation, Guyon's theorem, Concordant cable profile and its determination | CO6 | 1 |
| 5.3 | Design of Continuous Prestressed beams | CO6 | 1 |
| 5.4 | Composite construction of Prestressed and in situ Concrete: Types of composite construction | CO7 | 1 |
| 5.5 | Composite construction: Analysis of stresses, Flexural strength | CO7 | 1 |
| 5.6 | PSC Slabs - Types, Design and analysis of PSC One-way slabs | CO8 | 1 |
| 5.7 | Design and analysis of PSC two-way slabs | CO8 | 1 |

**Model Question Paper**

**QP CODE:**

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

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

**Course Code: CET 413**

**Course Name: Prestressed Concrete**

Max. Marks: 100 Duration: 3 hours

**Part A**

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

| Qn No | Question | Marks | Course outcome (CO) Assessed |
|---|---|---|---|
| | **Part A (Answer ALL Questions)** | | |
| 1 | Discuss the merits and demerits of prestressed concrete | 3 | CO1 |
| 2 | Distinguish between pretensioned and post-tensioned members | 3 | CO1 |
| 3 | List the various types of losses of prestress in pretensioned and post-tensioned members | 3 | CO1 |
| 4 | What are the various modes of failures in prestressed concrete beams due to shear and torsion? | 3 | CO2 |
| 5 | What do you mean by concordant cable profile | 3 | CO6 |
| 6 | List the various factors which influence the deflection in prestressed concrete members. | 3 | CO4 |
| 7 | What are the different types of composite structures? | 3 | CO7 |
| 8 | What is the necessity of providing reinforcements in the anchorage zone of a prestressed concrete beam? Give the supporting figures | 3 | CO5 |
| 9 | Briefly explain the importance of creep and shrinkage of concrete in long-term deflections of prestressed members. | 3 | CO4 |
| 10 | How does the prestress gets transferred to the member in pretensioned members. | 3 | CO5 |

| | | | |
|---|---|---|---|
| | **Part B**<br>**(Answer ANY ONE FULL question from each module)** | | |
| | **Module I** | | |
| 11 | a) A pretensioned beam 250 mm wide and 360 mm deep is prestressed by 10 wires of 8mm dia. Initial stress to 1000N/mm2 . The centroid of the steel wires is located at 105mm from the soffit. Determine the max.stress in concrete immediately after transfer allowing elastic shortening of concrete only at the level of centroid of the steel. If however, the concrete is subjected to additional shortening due to the creep and shrinkage and the steel is subjected to relaxation of stress of 5% of initial stress. Find the final percentage of loss of stress in steel wires. Take Es=210kN/mm2 , Ec=36.85kN/mm2 , $\phi$=1.60, take residual shrinkage strain =3X10-4<br>b) Derive the loss due to elastic shortening of concrete. | 8<br>6 | CO1<br>CO1 |
| 12 | A rectangular concrete beam, 100 mm wide by 250 mm deep, spanning over 8 m is prestressed by a straight cable carrying an effective prestressing force of 250 kN located at an eccentricity of 40 mm. The beam supports a live load of 1.2 kN/m.<br>a) Calculate the resultant stress distribution for the central cross section of the beam. The density of concrete is 24 kN/m$^3$.<br>b) Find the magnitude of the prestressing force with an eccentricity of 40 mm which can balance the stresses due to dead and live loads at the bottom fibre of the central section of the beam. | 14 | CO1 |
| | **Module II** | | |
| 13 | a) A prestressed girder of rectangular section 150 mm wide by 300 mm deep is to be designed to support an ultimate shear force of 130 kN. The uniform prestress across the section is 5 N/mm2 . Given the characteristic cube strength of concrete as 40 N/mm2 and Fe-415 HYSD bars of 8 mm diameter, design suitable spacing for the stirrups conforming to the Indian standard code IS: 1343 recommendations. Assume cover to the reinforcement as 50 mm. | 7 | CO2 |

| | | | |
|---|---|---|---|
| | b) A pretensioned girder having a T-section is made up of a flange 200 mm wide and 60 mm thick. The overall depth of the girder is 600 mm. The thickness of the web is 60 mm. The horizontal prestress at a point 300 mm from the soffit is 10 N/mm2 . The shear stress due to transverse load acting at the same point is 2.5 N/mm2 . Determine the increase in the principal tensile stress at this point if the T-section is subjected to a torque of 2 kN-m | 7 | CO2 |
| 14 | a) The horizontal prestress at the centroid of a concrete beam of rectangular cross section 340mm by 600mm, is 10N/mm2 and maximum shearing force on the beam is 90kN.Calculate the maximum principal tensile stress<br>b) A concrete beam of rectangular section, 300 mm wide and 800 mm deep is subjected to a twisting moment of 30 kNm and a prestressing force of 150 kN acting at an eccentricity of 220 mm. i) Calculate the maximum principal tensile stress. ii) If the beam is subjected to a maximum bending moment of 100 kNm in addition to the twisting moment, calculate the maximum principal tensile stress. | 6<br><br>8 | CO2<br><br>CO2 |
| | **Module III** | | |
| 15 | a) A beam of size 200 mm × 350 mm is prestressed with 12 wires of 7 mm diameter straight tendons located at a distance of 75 mm from the soffit of the beam. The wires are stressed to 750 N/mm2 . The beam supports an imposed load of 7 kN/m over a span of 8 m. The modulus of elasticity of concrete is 38 kN/mm2 , and density of concrete is 24 kN/m3 . Estimate the central deflection of the beam under the action of prestress, self-weight and live load. Compare this value with IS 1343 codal provisions<br>b) A concrete beam is prestressed by a sloping tendon having an eccentricity of e1 towards the soffit at centre of span and an eccentricity of e2 towards the top at supports. Find the ratio of these eccentricities for zero deflection at the centre of span due to prestress only. | 9<br><br>5 | CO4<br><br>CO4 |
| 16 | A prestressed concrete beam of rectangular cross-section is subjected to an effective prestressing force of 500 kN provided by 5 numbers of 12.5 mm diameter strands of cross-sectional area | 14 | CO3 |

| | | | |
|---|---|---|---|
| | 506 mm2 . The cross-sectional dimension of the beam is 450 mm × 600 mm. The eccentricity of the posttensioned tendon is 150 mm. A service load Bending Moment of 176 kNm, Torsional Moment of 56 kNm and Shear Force of 75kN are acting at the section of the beam. Take the cube strength of concrete as 40N/mm2 and the ultimate tensile strength of tendons as 1820 N/mm2 . Using IS 1343 codal provisions design the longitudinal and transverse reinforcements of the beam. | | |
| | **Module IV** | | |
| 17 | a) Estimate the transmission length at the ends of a pretensioned beam prestressed by 7-mm diameter wires. Assume the cube strength of concrete at transfer as 42 N/mm2 .<br>b) A pretensioned beam is prestressed using 5 mm diameter wires with an initial stress of 80 percent of the ultimate tensile strength of steel (fpu = 1600 N/mm2 ). The cube strength of concrete at transfer is 30 N/mm2 . (a) Calculate the transmission length (b) compute the bond stress at ¼ and ½ the transmission length from the end and (c) Calculate the overall average bond stress. | 9<br>5 | CO5<br>CO5 |
| 18 | The end block of a post tensioned concrete beam 300 mm×300 mm is subjected to a concentric anchorage force of 800 kN by a freyssinet anchorage system of area 1100mm2 . Design, Discuss and detail the anchorage reinforcement for the end block. | 14 | CO5 |
| | **Module V** | | |
| 19 | The floor slab of an industrial structure, spanning over 8 m is to be designed as a one-way prestressed concrete slab with parallel post-tensioned cables. The slab is required to supporta live load of 10 kN/sq.m with the compressive and tensile stress in concrete at any stage not exceeding 14 and zero 14 kN/sq.m respectively. Design a suitable thickness for the slab and estimate the maximum horizontal spacing of the Freysinet cables (12 of 5 mm diameter initially stressed to 1200 N/sq.mm) and their position at mid span section. The loss ratio is 0.8. | 14 | CO8 |

| | | | |
|---|---|---|---|
| 20 | a) A PSC beam of 230 mm wide and 450 mm deep is used over an span of 4m is pre stressed by a cable carrying a force of 650 kN & located at an eccentricity of 75mm. The beam supports three concentrated loads of 25 kN at each quarter span points. Determine the location of the pressure line in beam at centre, quarter & support sections. Neglect the moment due to self weight of the beam.<br>b) A two-span continuous prestressed concrete beam ABC (AB=BC = 15 m) has a uniform cross section with a width of 250 mm and a depth of 600 mm. The cable carrying an effective prestressing force of 500 kN is parallel to the axis of the beam and located at an eccentricity of 200 mm. Determine the secondary and resultant moment developed at mid support section B. | 7<br>7 | CO6<br>CO6 |

| CET423 | GROUND IMPROVEMENT TECHNIQUES | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 | 2019 |

**Preamble:** The course introduces the various types ground improvement techniques that can be adopted in different site conditions. It enables the students to choose the suitable ground improvement techniques to be adopted depends on the site condition and requirements.

**Prerequisite:** Geotechnical Engineering-I, Geotechnical Engineering-II

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

| Course Outcome | Description of Course Outcome |
|---|---|
| CO1 | Classify different ground improvement methods based on the soil suitability |
| CO2 | Outline the basic concept/ design aspects of various ground improvement methods |
| CO3 | Identify the construction procedure of different ground improvement methods |
| CO4 | Choose different application of geosynthetics and soil stabilisation in Ground improvement |

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

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

**Assessment Pattern**

| Bloom's Category | Continuous Assessment Tests | | End Semester Examination |
|---|---|---|---|
| | 1 | 2 | |
| Remember | 10 | | 10 |
| Understand | 10 | 10 | 30 |

| | | | |
|---|---|---|---|
| Apply | 30 | 40 | 60 |
| Analyse | | | |
| Evaluate | | | |
| Create | | | |

**Mark distribution**

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

**Continuous Internal Evaluation Pattern:**

Attendance : 10 marks

Continuous Assessment Test(2numbers) : 25 marks

Assignment/Quiz/Course project : 15marks

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

Part A contain 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 question form each Module. Each question should have a maximum if two subdivision and carry 14marks.

**Course Level Assessment Questions**

**CO1:** Classify different ground improvement methods based on the soil suitability

1. Explain the relevance of Ground improvement techniques.
2. Summarize different method of in-situ ground improvement techniques and its applications.

**CO2:** Outline the basic concept/ design aspects of various ground improvement methods

1. Explain the basic concept used in blasting technique
2. Explain the design consideration of soil nailing

**CO3:** Identify the construction procedure of different ground improvement methods

1. Explain Grouting technique used for Ground Improvement.
2. Explain the installation procedure of PVD

**CO4:** Choose different application of geosynthetics and soil stabilisation in Ground improvement

1. Illustrate the application of geo-textile as (a) Filtration (b) Drainage (c) Erosion control**.**
2. Explain the chemical aspects of lime stabilization

## Syllabus

**MODULE 1**.

Roll of ground improvement in foundation engineering- Classification of ground improvement methods-different problematic soil -selection of suitable ground improvement based on the soil condition-Emerging trends in ground improvement-Different materials used for ground improvement and its property

Brief introduction to sustainable method of ground improvement, Microbial methods

**MODULE 2**.

In situ Densification-Deep compaction and shallow compaction, Properties of compacted soil and compaction control.

Dynamic Compaction-Procedure-design considerations, soil suitability, Merit and demerit.

Vibration methods-Vibro compaction techniques-Blasting, Vibrating compactors

Vibro displacement methods-Vibro-flotation. Sand pile, Stone column, Lime pile-principle, installation procedure, basic design considerations, soil suitability, Merit and demerits

**MODULE 3**.

Drainage methods- Methods of dewatering systems-Open sump, Well points, Vaccuum and electroosmotic methods

Drains-type-drainage facility after construction-Foundation drain, Blanket drain, Interceptor drains

Precompression and Vertical Drain – Preloading, Vertical drain-General principle, Soil suitability, Type-sand drain, PVD-Installation procedure

**MODULE 4**.

Earth Reinforcement-Reinforcement materials-reinforced earth wall-design considerations-construction procedure

Soil nailing & Micro pile-basic concept-construction sequence-areas of application-design considerations-merit and demerit

Geosynthetics - use, type-function- filtration, drainage, separation-Application of geotextile in different works

**MODULE 5**.

Grouting Techniques- Grouting material-groutability-stabilization with cement, lime and chemicals

Classification of grouting techniques-particulate grouting, Compaction grouting, penetration grouting, jet grouting, displacement grouting-Procedure-soil suitability-merit and demerit.

Thermal method-stabilization by heating, stabilization by cooling

Soil stabilization- Fundamental concept of soil-cement stabilisation, Mechanism of lime stabilisation

**Text Books:**

1. P. Purushothama Raj, Ground Improvement Techniques , Laxmi Publications (P) Ltd.
2. Manfred. R. Hausmann, Engineering Principles of Ground Modification, McGraw Hill, 1989

**References:**

1. M.P. Moseley and K. Kirsch (Edited), Ground improvement, Second edition, Spon Press, Taylor and Francis group

**Course Contents and Lecture Schedule**

| Module | Topic | CO addressed | No. of Lectures |
|---|---|---|---|
| **1** | **Module I: Total lecture hours:6** | | |
| 1.1 | Roll of ground improvement in foundation engineering- | 1 | 1 |
| 1.2 | Classification of ground improvement methods | 1 | 1 |
| 1.3 | Different problematic soil -selection of suitable ground improvement based on the soil condition- | 1 | 1 |
| 1.4 | Emerging trends in ground improvement | 1 | 1 |
| 1.5 | Different materials used for ground improvement and its property | 1 | 1 |
| 1.6 | Brief introduction to sustainable method of ground improvement, Microbial methods | 1 | 1 |
| **2** | **Module II: Total lecture hours-8** | | |

| | | | |
|---|---|---|---|
| 2.1 | In situ Densification-Deep compaction and shallow compaction, Properties of compacted soil and compaction control. | 2 | 1 |
| 2.2 | Dynamic Compaction-Procedure-design considerations, soil suitability, Merit and demerit. | 2 | 1 |
| 2.3 | Vibration methods-Vibro compaction techniques- | 3 | 1 |
| 2.4 | Blasting, Vibrating compactors | 3 | 1 |
| 2.5 | Vibro displacement methods-Vibro-flotation. | 3 | 1 |
| 2.6 | Sand pile, Stone column, principle, installation procedure, basic design considerations, soil suitability, Merit and demerits | 2,3 | 2 |
| 2.7 | Lime pile-principle, installation procedure, basic design considerations, soil suitability, Merit and demerit | 2,3 | 1 |
| **3** | **Module III: Total lecture hours: 7** | | |
| 3.1 | Drainage methods- Methods of dewatering systems-Open sump, Well points, Vaccuum | 2,3 | 1 |
| 3.2 | Vaccuum and electroosmotic methods | 2,3 | 2 |
| 3.3 | Drains-type-drainage facility after construction-Foundation drain, Blanket drain, Interceptor drains | 2 | 1 |
| 3.4 | Precompression and Vertical Drain – Preloading, General principle, Soil suitability | 2,3 | 1 |
| 3.5 | Vertical drain-General principle, Soil suitability, Type-sand drain, PVD-Installation procedure | 2,3 | 2 |
| **4** | **Module IV: Total lecture hours: 7** | | |
| 4.1 | Earth Reinforcement-Reinforcement materials-reinforced earth wall, construction procedure | 2,3 | 2 |

| | | | |
|---|---|---|---|
| 4.2 | Soil nailing -basic concept-construction sequence-areas of application-design considerations-merit and demeri | 3 | 1 |
| 4.3 | Micro pile-basic concept-construction sequence-areas of application-design considerations-merit and demerit | 2,3 | 1 |
| 4.4 | Geosynthetics - use, type-function- filtration, drainage, separation-Application of geotextile in different works | 4 | 3 |
| **5** | **Module V: Total lecture hours: 8** | | |
| 5.1 | Grouting Techniques- Grouting material-groutability-stabilization with cement, lime and chemicals | 2,3 | 2 |
| 5.2 | Classification of grouting techniques-particulate grouting, Compaction grouting, penetration grouting, jet grouting, displacement grouting-Procedure-soil suitability-merit and demerit. | 2,3 | 3 |
| 5.3 | Thermal method-stabilization by heating , stabilization by cooling | 1,2 | 1 |
| 5.4 | Soil stabilization- Fundamental concept of soil-cement stabilisation, Mechanism of lime stabilisation | 4 | 2 |

**Model Question Paper**

Reg.No.:_____ Name:_____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION

**Course Code: CET423**

**Course Name: GROUND IMPROVEMENT TECHNIQUES**

Max.Marks:100 Duration: 3Hours

**PART A**

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

(10×3 marks = 30 marks)

1. Explain the importance of Ground improvement in foundation engineering.
2. Name any five-material used for ground improvement.
3. Explain the blasting method used for Ground improvement.
4. Write note on Column techniques for Ground improvement.
5. How Electro osmotic method is applied for Ground Improvement.
6. Write note on the importance of lowering the ground water in a construction site.
7. Outline the use of micro pile as ground improvement choice.
8. List different type of geosynthetics.
9. list the different type of grouting material used for ground improvement?
10. Explain method of stabilisation using cement.

**PART B**

***Answer one full question from each module*** (14 × 5 = 70 Marks)

**Module I**

11. (a) Categories different ground improvement methods based on the soil suitability (7)
    (b) Explain the property of material suitable for ground improvement (7)
12. (a) List the different method of insitu ground improvement techniques and its applications (10)
    (b) Explain the properties of material used for ground improvement (4)

**Module II**

13. (a) Explain the Dynamic Compaction for Ground improvement. (10)
    (b) Explain about the compaction control (4)
14. (a) Outline how the ground improvement are achieved by vibration techniques. (7)
    (b) What is Stone column? Explain its method of construction (7)

**Module III**

15. (a) Explain the application of vertical drain. (7)
    (b) What is PVD? Explain its advantage over other drains. (7)
16. (a) Illustrate the well point system of dewatering. (7)
    (b) Explain about different drains facility (7)

**Module IV**

17. Illustrate the application of geo-textile as (a) Filtration (b) Drainage (c) Erosion control.
18. Explain the design considerations of a) Reinforced Earth wall (b) Soil nailing

**Module V**

19. (a) Explain Grouting technique used for Ground Improvement. (10)
    (b) Explain the principle of ground freezing (4)
20. Describe the chemical aspects of lime stabilisation and its effects on adjacent soil.

| CET433 | HIGHWAY MATERIALS AND DESIGN | 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 characteristics of various highway materials, tests on highway materials, design of bituminous mixes, analysis and design of highway pavements etc.

**Prerequisite:** CET 206 GEO TECHNICAL ENGINEERING

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

| | |
|---|---|
| **CO 1** | Identify suitable materials for different types of pavements (K2, K3) |
| **CO 2** | Interpret material test results with respect to field conditions and standards (K2, K3) |
| **CO 3** | Apply the pavement material properties to analysis of pavements (K2,K3) |
| **CO 4** | Evaluate material properties and design pavement mixes.(K3,K4) |
| **CO 5** | Analyse and design the pavement, flexible or rigid, for the conditions prevailing at site (K3, K4) |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | | | | | | | | | | |
| **CO 2** | 3 | | 2 | | | 2 | | | | | | |
| **CO 3** | 3 | 2 | | 2 | | | | | | | | 2 |
| **CO 4** | 3 | 3 | 3 | 2 | | 2 | | | | | | 2 |
| **CO 5** | 3 | 3 | 3 | 3 | | 3 | | | | | | 2 |

**Assessment Pattern**

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

| | | | |
|---|---|---|---|
| Apply | **5** | **5** | **20** |
| Analyse | **5** | **5** | **30** |
| 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 3marks 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**
Identify the suitable materials for different types of pavement constructions?

**Course Outcome 2 (CO2)**
Assess the suitability of pavement materials with respect to field conditions of any site known to you.

**Course Outcome 3 (CO3)**
Explain the various properties of materials used in the analysis of pavements, why are they significant?

**Course Outcome 4 (CO4)**
1) What are the desirable properties of bituminous mixes?
2) Explain the steps involved in the bituminous mix design?
3) What are the techniques used?

**Course Outcome 5 (CO5)**

1) Design a flexible pavement for the conditions prevailing at a specific site(rural road through marshy land ).
2) Analyse the various stresses developed in a rigid pavement, for the specified requirements?

**Syllabus**

| | |
|---|---|
| **Module 1** | **Pavements and materials: Desirable properties and testing of road aggregates**<br><br>Introduction to highway pavements, Types and component parts of pavements, Factors affecting design and performance of pavements, Pavement Materials-Road aggregates, Tests on aggregates and specifications for flexible and rigid pavements, Principles and methods of Gradation for soil – Aggregate mixes. Alternate Materials for durable pavements -Artificial aggregates. |
| **Module 2** | **Desirable properties and testing of bitumen**<br><br>Properties and tests on Bituminous binders –Methods of grading, Emulsions – Properties and tests, Cut backs and Modified binders-Types, characteristics and uses, aging of bitumen and aging tests. |
| **Module 3** | **Testing of subgrade soil and pavement mixes**<br><br>Functions and significance of sub grade properties, Various methods of assessment of sub grade soil strength for pavement design. Testing of sub base, base course and interlayer materials.<br><br>Mix design procedures in mechanical stabilisation of soils, Design of bituminous mixes by Marshall, Hubbard - field and Hveem's methods |
| **Module 4** | **Design of flexible pavements**<br><br>Introduction to analysis and design of flexible pavements, Stresses and deflections in homogeneous masses, Burmister's 2 layer and 3 layer theories, Wheel load stresses, ESWL of multiple wheels, Repeated loads and EWL factors, Empirical, semi - empirical and theoretical approaches for flexible pavement design, Group index, CBR, Triaxial, Mcleod and Burmister layered system methods |
| **Module 5** | **Design of rigid pavements**<br><br>Introduction to analysis and design of rigid pavements, Types of stresses and causes, Factors influencing stresses, General conditions in rigid pavement analysis, Warping stresses, Frictional stresses, Combined stresses<br><br>Joints in cement concrete pavements, Joint spacings, Design of slab thickness, Design and detailing of longitudinal, contraction and expansion joints, IRC methods of Design |

**Text Books:**

1. Justo C.E.G , Veeraragavan A and Khanna S.K; Highway Engineering, Nem Chand Publishers, Revised 10th Ed, 2018.

2. Yoder E J and Witezak, M W Principles of Pavement Design, John Wiley and sons, 2nd Edition 2011.

3. Kadiyali L R: Highway Engineering, Khanna publication Revised Edition, 2017

**References**

1. Yang, H H Design of functional pavements, McGraw-Hill, 1973.
2.Atkins, H.N Highway Materials, Soils, and Concrete, Prentice Hall, 2002
3. Krebs, R.D. Highway Materials, McGraw Hill Text, 1971.
4. Relevant IRC codes
5. MoRTH specifications

**Course Content and lecture Schedule:**

| No. | Topic | Course Outcome | No. of Hrs |
|---|---|---|---|
| **1** | **Module 1** | | **Total:6** |
| 1.1 | Introduction to highway pavements, Types and component parts of pavements | CO1 | 1 |
| 1.2 | Road aggregates, Tests and specifications on aggregates for flexible and rigid pavements | CO1 | 2 |
| 1.3 | Principles and methods of Gradation for soil – Aggregate mixes | CO1 | 2 |
| 1.4 | Alternate Materials for durable pavements: artificial aggregates | | 1 |
| **2** | **Module 2** | | **Total: 6** |
| 2.1 | Properties and tests on bitumen -Bituminous binders – Methods of grading, | CO2 | 2 |
| 2.2 | Emulsions –Properties and tests, Cut backs and Modified binders-Types, characteristics and uses, | CO2 | 2 |
| 2.3 | Aging of bitumen and aging tests | | 2 |
| **3** | **Module 3** | | **Total: 8** |
| 3.1 | Functions and significance of sub grade properties, Various methods of assessment of sub grade soil strength for pavement design | CO3 | 2 |
| 3.2 | Soil stabilization -Mix design procedures in mechanical stabilization of soils, | CO4 | 3 |
| 3.3 | Sub base, base course mixes and interlayers. Design of bituminous mixes by Marshall, Hubbard - field and Hveem's methods | CO4 | 3 |
| **4** | **Module 4** | | **Total: 8** |
| 4.1 | Introduction to analysis and design of flexible pavements, Stresses and deflections in homogeneous masses, Burmister's 2 layer and 3 layer theories, | CO5 | 2 |
| 4.2 | Wheel load stresses, ESWL of multiple wheels, Repeated loads and EWL factors, | CO5 | 2 |
| 4.3 | Empirical and semi - empirical approaches for flexible pavement design, Group index, CBR, Triaxial and Mcleod methods | CO5 | 2 |
| 4.4 | Theoreticalapproaches for flexible pavement design- | CO5 | 2 |

| | | | |
|---|---|---|---|
| | Burmister layered system methods of design | | |
| **5** | **Module 5** | | **Total: 8** |
| 5.1 | Introduction to analysis and design of rigid pavements, Types of stresses and causes, Factors influencing stresses, General conditions in rigid pavement analysis, | CO5 | 2 |
| 5.2 | Warping stresses, Frictional stresses, Combined stresses | CO5 | 2 |
| 5.3 | Joints in cement concrete pavements, Joint spacings, Design and detailing of longitudinal, contraction and expansion joints, | CO5 | 2 |
| 5.4 | Design of slab thickness and IRC methods of Design | CO5 | 2 |

**Model Question Paper**

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
**SEVENTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: CET 433**
**Course Name: HIGHWAY MATERIALS AND DESIGN**

Max. Marks:100 Duration: 3 hrs

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

1 Differentiate between flexible and rigid pavements?

2 Explain the term Combined Flakiness and Elongation index?

3 What are the different methods of grading of bituminous binders?.

4 Explain the aging of bitumen?

5 What are the desirable properties of subgrade soil?.

6 What are the factors in design of mix for mechanical stabilization?

7 Mention the effects of repeated applications of loads on pavements?

8 Explain the concept of Equivalent single wheel load?

9 How the warping stresses in rigid pavements calculated?

10 The width of expansion joint gap is 2.5cm in a cement concrete pavement.If the laying temperature is $10^{o}$C and the maximum slab temperature in summer is $54^{o}$C, Calculate the spacing between expansion joints. coefficient of thermal expansion of concrete as $10*10^{-6}$per$^{o}$C.

(3 x 10=30 marks)

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

**MODULE 1**

11 a. Explain the principles of various tests for judging the suitability of road aggregates? Specify the desirable values of the test results 14

**OR**

12 a. Explain the Principles and methods of Gradation for soil – Aggregate mixes 10

b. Write short notes on the alternate Materials for durable pavements 4

**MODULE 2**

| | | | |
|---|---|---|---|
| 13 | a. | Explain the uses of emulsion and how are they prepared? | 7 |
| | b. | List the different types of cutbacks and explain the various tests carried out on cutback bitumen? | 7 |

**OR**

| | | | |
|---|---|---|---|
| 14 | | What are the various tests carried out on bitumen? Briefly mention the principles and uses of each test | 14 |

**MODULE 3**

| | | | |
|---|---|---|---|
| 15 | a. | With the help of graphs, explain the procedure for the Marshall method of design of bituminous mixes? | 8 |
| | b. | Explain the various methods to evaluate the soil strength for pavement design?. | 6 |

**OR**

| | | | |
|---|---|---|---|
| 16 | a. | Explain the principles of soil stabilisation | 4 |
| | b. | Explain the mix design procedures in mechanical soil stabilization | 10 |

**MODULE 4**

| | | | |
|---|---|---|---|
| 17 | a. | State the advantages and disadvantages of group index method for design of flexible pavements. | 6 |
| | b. | Explain the concept of CBR and give the step by step procedure for design of flexible pavements as per IRC recommendations. | 8 |

**OR**

| | | | |
|---|---|---|---|
| 18 | a. | Illustrate the application of Burmister's 2 layer theory in pavement design? | 6 |
| | b. | Estimate the thickness of sub base, base and wearing surface course of a flexible pavement system from following data, using Kansas triaxial test method. Modulii values of subgrade, sub base, base and wearing course are 100kg/cm$^2$, 200kg/cm$^2$ , 400kg/cm$^2$ and 1000kg/cm$^2$ respectively. Given that radius of contact = 15cm, Design deflection = 0.25cm, assume saturation coefficient based on rainfall as 0.5 and traffic coefficient as 2. Wheel load = 4080kg. | 8 |

**MODULE 5**

| | | | |
|---|---|---|---|
| 19 | a. | Calculate the stresses at interior, edge and corner regions of a C.C. pavement using Wester Gaard's stress equation for the following data:<br><br>Wheel load=5100 kg, Modulus of elasticity of concrete=3x10$^5$ kg/cm$^2$, poisson's ratio=0.15, pavement thickness=24cm, modulus of subgrade reaction =6 kg/cm$^3$, radius of contact area=15cm | 7 |

b. Define 1) Modulus of Subgrade reaction 2) Radius of relative stiffness 3) Equivalent radius of resisting section 7

**OR**

20 a. Estimate the thickness of cement concrete pavement using the method suggested by Indian Roads Congress 14

Modulus of elasticity of concrete -3 *$10^5$ kg/$cm^2$

Modulus of rupture of concrete – 40 kg/$cm^2$

Poissons ratio of concrete – 0.15

Modulus of subgrade reaction - 6 kg/$cm^2$

Wheel load =5100kg

Radius of contact area =15cm

| CET443 | APPLIED HYDROLOGY | 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 advanced concepts of hydrology and hydrologic systems. The course aim to impart the knowledge on the availability of water on hydrosphere, scientific methods quantifying the components of hydrologic cycle, statistical analysis of hydrologic datasets etc

**Pre-requisite:** CET307 HYDROLOGY AND WATER RESOURCES ENGINEERING

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

| | |
|---|---|
| CO1 | Describe or estimate the different components of hydrologic cycle |
| CO2 | Explain the behavior of catchments and quantify the response of the catchment |
| CO3 | Apply the concept of hydrograph for runoff computation |
| CO4 | Apply hydrological and statistical principles for estimation of flood discharge |
| CO5 | Determine the aquifer parameters and assess the groundwater quality |

**CO - PO Mapping**

| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CET443 Applied Hydrology | 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 | : 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 Level Assessment Questions**

| Qn No | Question | Marks | Course outcome (CO) Assessed |
|---|---|---|---|
| | **Part A (Answer ALL Questions)** | | |
| 1 | Explain probable maximum precipitation | 3 | CO1 |
| 2 | Explain Green Ampt model for estimation of infiltration | 3 | CO1 |
| 3 | What are the factors to be considered in selection of site for a stream gauging station ? | 3 | CO2 |
| 4 | Explain the concept of stream ordering | 3 | CO2 |
| 5 | Explain linear reservoir model | 3 | CO3 |
| 6 | State the limitations of rational method of runoff computation | 3 | CO1, CO2 |
| 7 | Differentiate hydrologic routing and hydraulic routing | 3 | CO4 |
| 8 | Explain different methods of flood control | 3 | CO4 |
| 9 | Explain Electrical resistivity method | 3 | CO5 |
| 10 | Explain Method of images | 3 | CO5 |
| | **Part B (Answer ANY ONE FULL question from each module)** | | |
| | **Module I** | | |
| 11 (a) | What are IDF curves ? Explain its practical use | 5 | CO1 |
| 11 (b) | Estimate the PET of an area for the season November to February in which wheat is grown. The area is in North India at a latitude of $30^0$ N with mean monthly temperatures and % | 9 | CO1 |

daytime hours as below:

| Month | November | December | January | February |
|---|---|---|---|---|
| Monthly day time hours | 7.19 | 7.15 | 7.30 | 7.03 |
| | 16.5 | 13 | 11 | 14.5 |

| | | | |
|---|---|---|---|
| 12 (a) | Explain Penmann-Montieth method of evapotranspiration estimation | 3 | CO1 |
| 12 (b) | The annual rainfall data of a station A and the annual rainfall values of 6 neighboring stations are given below. Check the consistency of rainfall record of station A, by double mass curve method | 11 | CO1 |

| Year | Annual rainfall of Station A (cm) | 6 station average (cm) |
|---|---|---|
| 1969 | 177 | 143 |
| 1970 | 144 | 132 |
| 1971 | 178 | 146 |
| 1972 | 162 | 147 |
| 1973 | 194 | 161 |
| 1974 | 168 | 155 |
| 1975 | 196 | 152 |
| 1976 | 144 | 117 |
| 1977 | 160 | 128 |
| 1978 | 196 | 193 |
| 1979 | 141 | 156 |
| 1980 | 158 | 164 |
| 1981 | 145 | 155 |
| 1982 | 132 | 143 |
| 1983 | 95 | 115 |
| 1984 | 148 | 135 |
| 1985 | 142 | 163 |
| 1986 | 140 | 135 |
| 1987 | 130 | 143 |
| 1988 | 137 | 130 |

| | | | |
|---|---|---|---|
| | 1989 \| 130 \| 146<br>1990 \| 163 \| 161 | | |
| | **Module II** | | |
| 13 (a) | Explain area-velocity method of stream gauging | 4 | CO2 |
| 13 (b) | Three points on a rating curve of a stream gauging station obtained from an eye-fit for the stage discharge data have the following coordinates : (100 $m^3$/s; 121.67 m) (200 $m^3$/s,122.23 m) and (400 $m^3$/s,123.04). Determine the equation of the rating curve and compute the discharge in the stream corresponding to a stage of 124.5 m | 10 | CO2 |
| 14 (a) | Define (i) form factor (ii) Compactness coefficient (iii) drainage density (iv) time of concentration | 8 | CO2 |
| 14 (b) | Explain the method of extrapolation of stage discharge curve | 6 | CO2 |
| | **Module III** | | |
| 15 (a) | What are instantaneous Unit hydrographs ? Explain Nash's conceptual model | 5 | CO3 |
| 15 (b) | The effective rainfall hyetograph of a complex storm has duration of 12 h with rainfall intensity 2, 0.75 and 4 cm/h respectively in successive 4 h periods. The ordinates of the corresponding DRH read at 4 h intervals are 160, 300, 570, 636, 404, 234, 105 and 48 $m^3$/sec. Determine the ordinates of 4 hr unit hydrograph using the deconvolution method | 9 | CO3 |
| 16 | From the topographical map of a drainage basin, the following quantities are measured. A=3480 $km^2$; Length of the main stream (L) is 148 km and distance from the centroid of the basin to the catchment outlet (Lc) is 74 km. The 12 hr unit hydrograph derived for the basin has a peak ordinate of 155 $m^3$/s occurring at 40 hrs. Derive the 4 hr synthetic unit hydrograph of sub- basin of the catchment, having drainage area 2500 $km^2$, L=100km and Lc=50 km using Snyder's method | 14 | CO3 |
| 17 (a) | Data of monthly rainfall and runoff available for a basin are shown in Table. Develop a linear regression model between rainfall (P) and runoff (Q) and plot the relation.<br>Month: 1 \| 2 \| 3 \| 4 \| 5 \| 6 \| 7 \| 8 \| 9<br>P(cm): 4 \| 40 \| 30 \| 25 \| 20 \| 15 \| 10 \| 5 \| 50<br>Q (cm): 0.2 \| 9 \| 5 \| 4.5 \| 2.5 \| 2 \| 1 \| 0.5 \| 14 | 8 | CO3 |
| 17 (b) | Explain the deconvolution method of derivation of unit hydrograph from complex storms | 6 | CO3 |
| | **Module IV** | | |
| 18 (a) | Flood frequency computations for a river by using Gumbel's method, yielded the following results: | 7 | CO4 |

<table>
<tr><td></td><td>
<table>
<tr><th>Return period (T)(Years)</th><th>Peak flood ($m^3$/sec)</th></tr>
<tr><td>40</td><td>27000</td></tr>
<tr><td>80</td><td>31000</td></tr>
</table>
Estimate the flood magnitude in the river with the return period of 240 years.
</td><td></td><td></td></tr>
<tr><td>18 (b)</td><td>Explain how you will you determine the Muskingum parameters</td><td>7</td><td>CO4</td></tr>
<tr><td>19 (a)</td><td>Route the flood hydrograph given below through a channel reach and derive the outflow hydrograph. The values of Muskingum parameters K and x are 12 h and 0.278 respectively
<table>
<tr><td>Time(h)</td><td>0</td><td>4</td><td>8</td><td>12</td><td>16</td><td>20</td><td>24</td><td>28</td><td>32</td><td>36</td><td>40</td><td>44</td><td>48</td><td>52</td><td>56</td></tr>
<tr><td>Flow ($m^3$/s)</td><td>42</td><td>68</td><td>116</td><td>164</td><td>194</td><td>200</td><td>192</td><td>170</td><td>150</td><td>128</td><td>106</td><td>88</td><td>74</td><td>62</td><td>54</td></tr>
</table>
</td><td>10</td><td>CO4</td></tr>
<tr><td>19 (b)</td><td>Explain Flood routing and its importance</td><td>4</td><td>CO4</td></tr>
<tr><td></td><td>Module V</td><td></td><td></td></tr>
<tr><td>20 (a)</td><td>Derive partial differential equation for unsteady flow in a confined aquifer</td><td>10</td><td>CO5</td></tr>
<tr><td>20 (b)</td><td>Explain method of images</td><td>4</td><td>CO5</td></tr>
<tr><td>21 (a)</td><td>Explain the methods of artificial recharge of groundwater</td><td>7</td><td>CO5</td></tr>
<tr><td>21 (b)</td><td>Explain the methods of control of seawater intrusion</td><td>7</td><td>CO5</td></tr>
<tr><td>22 (a)</td><td>Derive Ghyben-Herzberg relationship</td><td>6</td><td>CO5</td></tr>
<tr><td>22 (b)</td><td>In an artesian aquifer, the drawdown is 1.2 m at a radial distance of 10 m from a well after two hours of pumping. On the basis of Thies' non- equilibrium equation determine the pumping time for the same drawdown at a radial distance of 30 m from the well</td><td>8</td><td>CO5</td></tr>
</table>

## Syllabus

**Module I (7 Hours)**

Hydrology and Hydrologic cycle -Test for consistency of rainfall records – Double mass curve method. Analysis of rainfall data – intensity, duration, frequency (IDF) curves; depth area duration (DAD) curve. Frequency analysis-probable maximum precipitation, Hydrologic abstractions- Infiltration- Green Ampt method, Evapotranspiration- methods of estimation-
Blaney Criddle method (problem)- penman method, Penmann-Montieth method

**Module II (7 hours)**

Catchment characteristics, classification of streams - stream pattern and stream order; Stream gauging – methods- rating of current meter; Extension of stage discharge curve, Adjustment of stage discharge curve; selection of site for stream gauging stations.

**Module III (7 Hours)**

Runoff - Computation of runoff– Hydrograph analysis- S-hydrograph, unit hydrograph from complex storm, synthetic unit hydrograph, Instantaneous unit hydrograph (Brief description only) , linear reservoir model. Application of linear regression in hydrologic modeling

**Module IV (7 Hours)**

Design flood and their Estimation - Different methods; Flood frequency studies -Gumbel's method; Flood routing-Hydrologic and Hydraulic routing, Flood routing through reservoirs – concept only. Flood routing through channels - Muskingum method, determination of Muskingum parameters. Flood control methods - Flood forecasting and warning (Brief descriptions only)

**Module V (7 Hours)**

Partial differential equation governing unsteady groundwater flow- Evaluation of aquifer parameters - Theis method -Jacob's approximation method. Well flow near aquifer boundaries - Method of images, Surface investigation of groundwater - Electrical resistivity method. Graphical representation of hydrochemical data, Pollution of groundwater- sources; Seawater intrusion- Ghyben-Herzberg relationship, Method of control of seawater intrusion; Artificial recharge of groundwater.

**Text Books:**

1. Raghunath H.M. Hydrology: Principles, Analysis and Design. New Age International New Delhi 2006.
2. VenTe Chow. Hand book of Applied Hydrology, Tata McGraw Hill, 1988
3. Subramanya K. Engineering Hydrology, Tata McGraw Hill, 2013.
4. Reddy JR, A text book of Hydrology, Laxmi Publishers

**References:**

1. Ojha, C.S.P, R. Berndtsson, P.Bhunya, Engineering Hydrology, Oxford University Press
2. Todd D. K. Ground Water Hydrology, Wiley, 2005.
3. H.M Raghunath. Groundwater. New Age International New Delhi 2007
4. Garg S. K. Hydrology and Water Resources Engineering, Khanna Publishers New Delhi 2005.

5. Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd. 2009

**Course Contents and Lecture Schedule**

| Module | Topic | COs Mapped | Hours |
|---|---|---|---|
| **Module I** | | | |
| 1 | Hydrology and Hydrologic cycles | CO1 | 1 |
| 2 | Test for consistency of rainfall data – Double Mass Curve | CO1 | 1 |
| 3 | Analysis of rainfall data intensity, duration, frequency (IDF) curves | CO1 | 1 |
| 4 | Depth area duration (DAD) curve. Frequency analysis-probable maximum precipitation | CO1 | 1 |
| 5 | Hydrologic abstractions- Infiltration- Green Ampt method | CO1 | 1 |
| 6 | Evapotranspiration- methods of estimation-Blaney Criddle method | CO1 | 1 |
| 7 | Penman method, Penmann-Montieth method | CO1 | 1 |
| **Module II** | | | |
| 8 | Catchment Characteristics | CO2 | 1 |
| 9 | Classification of streams – Stream pattern and stream order. | CO2 | 1 |
| 10 | Stream gauging- different methods | CO2 | 1 |
| 11 | Selection of site for stream gauging stations | CO2 | 1 |
| 12 | Stage Discharge Curve | CO2 | 1 |
| 13 | Extension of stage discharge curve | CO2 | 1 |
| 14 | Adjustment of stage discharge curve | CO2 | 1 |
| **Module III** | | | |
| 15 | Runoff - Computation of runoff | CO1,CO2 | 1 |
| 16 | Hydrograph analysis and S- Hydrograph | CO3 | 2 |
| 17 | Unit hydrograph from complex storm | CO3 | 1 |
| 18 | Synthetic unit hydrograph | CO3 | 1 |
| 19 | Instantaneous unit hydrograph, Linear reservoir model | CO3 | 1 |
| 20 | Application of linear regression in hydrologic modeling | CO1, CO3 | 1 |
| **Module IV** | | | |
| 21 | Design flood and their Estimation - Different methods | CO4 | 1 |
| 22 | Flood frequency studies -Gumbel's method | CO4 | 1 |
| 23 | Flood routing-Hydrologic and Hydraulic routing | CO4 | 1 |
| 24 | Flood routing through reservoirs – concept and approaches | CO4 | 1 |
| 25 | Flood routing through channels - Muskingum method | CO4 | 2 |
| 26 | Flood control methods , Flood forecasting and warning | CO1, CO4 | 1 |
| **Module V** | | | |
| 27 | Partial differential equation governing unsteady groundwater flow; Evaluation of aquifer parameters - Theis method | CO5 | 1 |

| | | | |
|---|---|---|---|
| 28 | Jacob's approximation method | CO5 | 1 |
| 29 | Well flow near aquifer boundaries - Method of images | CO5 | 1 |
| 30 | Surface investigation of groundwater - Electrical resistivity method. | CO5 | 1 |
| 31 | Graphical representation of hydrochemical data, Pollution of groundwater- sources; | CO5 | 1 |
| 32 | Seawater intrusion- Ghyben-Herzberg relationship, Method of control of seawater intrusion; Artificial recharge of groundwater. | CO5 | 2 |

**Model Question Paper**

**Reg No.:……..**

**Name:……**

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

**Course Code: CET443**
**Course Name: APPLIED HYDROLOGY**

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

**PART A**

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

1 Explain Probable maximum precipitation

2 Explain Green Ampt model for estimation of infiltration

3 What are the factors to be considered in selection of site for a stream gauging station ?

4 Explain the concept of stream ordering

5 Explain S-hydrograph and its use

6 State the limitations of rational method of runoff computation

7 Differentiate hydrologic routing and hydraulic routing

8 Explain different methods of flood control

9 Explain Electrical resistivity method for subsurface investigations

10 Explain Method of images 10*3=30

**PART B**

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

**Module I**

11 a. What are the causes of inconsistency of rainfall records? Explain double mass curve method for checking the consistency of rainfall records (5 Marks)

b. Determine the yearly consumptive use ofwater for sugarcane for the following data by Blaney-criddle method (9 Marks)

| Month | Monthly mean Temperature ($^oC$) | Monthly Crop coefficient k | Percent sunshine hours, P |
|---|---|---|---|
| January | 13.1 | 19.05 | 7.38 |

| | | | |
|---|---|---|---|
| February | 15.7 | 20.32 | 7.02 |
| March | 20.7 | 21.59 | 8.39 |
| April | 27.0 | 21.59 | 8.69 |
| May | 31.1 | 22.86 | 9.48 |
| June | 33.0 | 24.13 | 9.41 |
| July | 30.6 | 25.40 | 9.60 |
| August | 29.0 | 25.40 | 9.60 |
| September | 28.2 | 24.13 | 8.33 |
| October | 24.7 | 22.86 | 8.01 |
| November | 18.8 | 21.59 | 7.25 |
| December | 13.7 | 19.05 | 7.06 |

**OR**

12 a. Explain any three methods for determination of evapotranspiration (9 Marks)

b. What are IDF curves ? Explain its practical use? (5 Marks)

**Module II**

13 a. Define (i) compactness coefficient (ii) Ordering of streams (iii) stream patterns (7 Marks)

b. Three points on a rating curve of a stream gauging station obtained from an eye-fit for the stage discharge data have the following coordinates : (100 $m^3/s$; 121.67 m) (200 $m^3/s$,122.23 m) and (400 $m^3/s$,123.04). Determine the equation of the rating curve and compute the discharge in the stream corresponding to a stage of 124.5 m (7 Marks)

**OR**

14 a. Explain current meter rating curve and its use. How it is different from stage discharge curve ? (10 Marks)

b. Explain the classification of streams (4 Marks)

**Module III**

15 a. What are instantaneous Unit hydrographs ? Explain Nash's conceptual model (5 Marks)

b. The effective rainfall hyetograph of a complex storm has duration of 12 h with rainfall intensity 2, 0.75 and 4 cm/h respectively in successive 4 h periods. The ordinates of the corresponding DRH read at 4 h intervals are 160, 300, 570, 636, 404, 234, 105 and 48 $m^3$/sec. Determine the ordinates of 4 hr unit hydrograph using the deconvolution method (9 Marks)

**OR**

16 . From the topographical map of a drainage basin, the following quantities are (14 Marks)

measured. A=3480 $km^2$; Length of the main stream (L) is 148 km and distance from the centroid of the basin to the catchment outlet (Lc) is 74 km. The 12 hr unit hydrograph derived for the basin has a peak ordinate of 155 $m^3/s$ occurring at 40 hrs. Derive the 4 hr synthetic unit hydrograph of sub-basin of the catchment, having drainage area 2500 $km^2$, L=100km and Lc=50 km using Snyder's method (10 Marks)

**Module IV**

17 a. Explain any two empirical methods for computation of flood discharge. (4 Marks)

b. .Flood frequency computations for a river by using Gumbel's method, yielded the following results: (10 Marks)

| Return period T (years) | Peak flood ($m^3/s$) |
|---|---|
| 50 | 40,809 |
| 100 | 46,300 |

Estimate the flood magnitude in the river with the return period of 500 years.

**OR**

18 a. Explain flood warning and its importance (4 Marks)

b. Route the flood hydrograph given below through a channel reach and derive the outflow hydrograph. The values of Muskingum parameters K and x are 12 h and 0.278 respectively (10 Marks)

| Time(h) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3/s$) | 42 | 68 | 116 | 164 | 194 | 200 | 192 | 170 | 150 | 128 | 106 | 88 | 74 | 62 | 54 |

**Module V**

19 a. Derive Ghyben-Herzberg relationship (6 Marks)

b. In an artesian aquifer, the drawdown is 1.2 m at a radial distance of 10 m from a well after two hours of pumping. On the basis of Thies' non-equilibrium equation determine the pumping time for the same drawdown at a radial distance of 30 m from the well (8Marks)

**OR**

20 a. Derive partial differential equation for unsteady flow in a confined aquifer (8 Marks)

b. Explain the methods of artificial recharge of groundwater (6 Marks)

| CET453 | CONSTRUCTION PLANNING AND MANAGEMENT | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 | 2019 |

**Preamble:** Construction Planning and Management is an elective course designed to provide in-depth knowledge in the planning and management of construction projects. The course details various operations encountered in a construction project in different phases throughout the lifecycle of a project, from planning, design, construction and operations. The course also helps students to develop the required skills to plan and manage various types of construction projects effectively and efficiently using the latest technologies like BIM.

**Prerequisite:** CET 309 Construction Technology and Management

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

| Course Outcome | Description of Course Outcome | Prescribed learning level |
|---|---|---|
| CO1 | Apply knowledge of Planning and Management for planning and execution of Construction Projects | Applying |
| CO2 | Explain techniques for Project Planning, Scheduling, Construction Administration and Management | Understanding |
| CO3 | Identify the criteria for selecting the appropriate method and tools as per the requirement of each project or site. | Understanding |
| CO4 | Discuss the latest industry standards and technologies used in construction projects for planning and management. | Understanding |
| CO5 | Explain the financial and legal aspects involved in a construction project. | Understanding |

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

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

**Assessment Pattern**

| Bloom's Category | Continuous Assessment Tests | | End Semester Examination |
|---|---|---|---|
| | 1 | 2 | |
| Remember | 10 | 10 | 10 |
| Understand | 30 | 30 | 70 |
| Apply | 10 | 10 | 20 |
| Evaluate | | | |
| Analyse | | | |
| Create | | | |

**Mark distribution**

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

**Continuous Internal Evaluation Pattern:**

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

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

**Course Level Assessment (Sample) Questions**

**CO1: Apply knowledge of Planning and Management for planning and execution of Construction Projects**

1. How do you structure a team for a project? What do you consider?
2. What are the functions of construction management and give its applications?
3. What actions would you take if a project is falling behind schedule or exceeding the project's budget?
4. What would you do if some of your workers were not using the necessary safety equipment?

**CO2: Explain techniques for Project Planning, Scheduling , Construction Administration and Management**

1. List out the various network techniques in construction management.
2. Name the resource allocation methods and give the steps involved in any one

of the resource allocation methods.

3. Explain the different costs involved in material management for material, labour and expenses.

**CO3: Identify the criteria for selecting the appropriate method and tools as per the requirement of each project or site.**

1. What methods do you use to monitor and track the progress of your construction project?
2. Elucidate the methods to prioritize the necessary tasks for a project.
3. How do you know when a construction project is well-executed and what do you look for in quality control?

**CO4: Discuss the latest industry standards and technologies used in construction projects for planning and management.**

1. What are some of the major uses of BIM?
2. What is the difference between Retained Logic & Override Logic in progress update?
3. What is Clash Detection? How does it help in Construction Projects?

**CO5: Explain the financial and legal aspects involved in a construction project.**

1. What factors would you consider before negotiating contracts or rates?
2. Explain the different laws relating to wages.
3. Explain legal and financial aspects of accidents in construction projects.

## Syllabus

**Module 1**

Introduction: Objectives of construction planning and management. Importance of Management in Construction, Construction team- Roles, responsibilities and skills.

Organisation and Hierarchy in Construction Projects – Types, Characteristics, Functions and Flow charts.

Construction scheduling: Review of CPM and PERT (AoN network), Time-cost trade-off – Cost optimization through the crashing of a network, Resource smoothing and resources levelling – concept only.

**Module 2**

Introduction to BIM Technology: Define BIM and BIM model, Describe workflow in using BIM in the building lifecycle, Model-Based cost estimating, Perform Simulations, Apply BIM to reduce error and change orders in projects, Evaluate and communicate ideas related to the use of BIM in the building life cycle, BIM Benefits: Case Studies, Organizational Maturity and Dimensions, Construction Management and Planning using BIM

Labour Legislations pertaining to the construction industry, Payment of Wages Act, Minimum Wages Act, Contract Labour Act, Labour Welfare Fund Act, Workmen's Compensation Act.

**Module 3**

Human Resource Management: manpower estimation at various stages, recruitment, training, under and overmanning.

Materials Management: Materials of construction, classification codification, ABC analysis, estimation of materials procurement, inventory/stock control, Economic Order Quantity, purchase procedure, stores management

Quality control in Construction: Importance of quality, elements of quality, organization for quality control, quality assurance technique.

Construction Safety Management: Important causes of accidents on construction sites, safety measures, safety benefits to employees, employees and customers.

**Module 4**

Economics of Project Management: Economic analysis of projects – NPV, Rate of return analysis, cost-benefit analysis.

Tendering – E Tendering / Electronic Process.

Contract – Contract documents and conditions of Contract, Contract agreement

Technical terms only - Administrative approval, Technical Sanction, Secured Advance, Mobilization Advance, Heads of accounts in government organization, Earnest money deposit (EMD) and Security deposit (SD). Accounting- Terms only- Work Abstract, Cash book, Work register, Accounting for the materials, Measurement book, Muster roll and Record of Bills

**Module 5**

Budgetary Control Systems: Types of budgets, new approaches for budgeting, responsibility of accounting, profit centre approach.

Financial Management: Meaning and scope, financial statement analysis, financial ratio analysis, funds flow analysis.

Working Capital Management: Meaning, policy for working capital, estimating working capital needs. Capital investment decision, long term financing working of financial institutions in India and abroad, self-financing, financing mechanisms.

**Text Books:**

1. Srinath, L.S. PERT and CPM Principles and Applications, 3rd ed. Affiliated East-West Press, New Delhi 2015.
2. Kumar Neeraj Jha, Construction Project Management, 2nd ed Pearson, Dorling Kindersley (India) pvt. Ltd 2015
3. K. K. Chitkara, Construction Project Management Planning Scheduling & Controlling, Tata McGraw Hill, New Delhi 2014.

**References:**

1. Gupta, B.L. and Gupta, Amit. Construction Management, Machinery and Accounts, 3rd ed. Standard Pub, 2005.
2. Loraine, R.K. Construction Management in Developing Countries. Thomas Telford, London, 1993.
3. Singh, Harpal. Construction Management and Accounts 14th ed. Tata McGraw-Hill Pub., New Delhi, 1981.
4. Gould, E. Frederick and Joyce, E. Nancy. Construction Project Management. Prentice Hall, New Jersey, 2000.
5. Shrivastava, U.K. Construction Planning and Management, 3rd ed. Galgotia Pub., New Delhi, 2004
6. Brad Hardin, Dave McCool . BIM and Construction Management: Proven Tools, Methods, and Workflows Paperback – 2017 .

**Course Contents and Lecture Schedule**

| Module | Topic Course | Course Outcomes Addressed | No. of Lectures |
|---|---|---|---|
| 1 | **Module I : Total lecture hours : 7** | | |
| 1.1 | Introduction: Objectives of construction planning and management. Importance of Management in Construction, Construction team- Roles, responsibilities and skills. | CO2 | 1 |
| 1.2 | Organisation and Hierarchy in Construction Projects -Types, Characteristics, Functions and Flow charts. | CO1, CO2 | 2 |
| 1.3 | Review of CPM and PERT, Time-cost trade-off – Cost optimization through the crashing of a network, Resource smoothing and resources levelling – concept only. | CO1, CO2 | 4 |
| 2 | **Module II: Total lecture hours: 7** | | |
| 2.1 | Introduction to BIM Technology: Define BIM and BIM model, Describe workflow in using BIM in the building lifecycle, Model-Based cost estimating, Apply BIM to reduce error and change orders in projects | CO2, CO3, CO4 | 3 |
| 2.2 | Evaluate and communicate ideas related to the use of BIM in the building life cycle, BIM Benefits: Case Studies, Organizational Maturity and Dimensions, Construction Management and Planning using BIM | CO1, CO3, CO4 | 2 |
| 2.3 | Labour Legislations pertaining to the construction industry, Payment of Wages Act, Minimum Wages Act, Contract Labour Act, Labour Welfare Fund Act, Workmen's Compensation Act. | CO2, CO5 | 2 |
| 3 | **Module III: Total lecture hours: 6** | | |
| 3.1 | Human Resource Management: manpower estimation at various stages, recruitment, training, under and overmanning. | CO1 | 1 |
| 3.2 | Materials Management: Materials of construction, classification codification, ABC analysis, Estimation of materials procurement, inventory/stock control, Economic Order Quantity, purchase procedure, stores management. | CO1 | 2 |
| 3.3 | Quality control in Construction: Importance of quality, elements of quality, organization for quality control, quality assurance technique. | CO1 | 1 |
| 3.4 | Construction Safety Management: Important causes of accidents, safety measures, safety benefits to employees, employees and customers. | CO2 | 2 |
| 4 | **Module IV: Total lecture hours: 7** | | |
| 4.1 | Economics of Project Management: Economic analysis of projects, – NPV, Rate of return analysis, cost-benefit | CO2, CO4 | 2 |

| | | | |
|---|---|---|---|
| | analysis. | | |
| 4.2 | Tendering – E Tendering / Electronic Process. | CO2, CO4 | 1 |
| 4.3 | Contract – Contract documents and conditions of Contract, Contract agreement | CO2 | 2 |
| 4.4 | Technical terms only - Administrative approval, Technical Sanction, Secured Advance, Mobilization Advance, Heads of accounts in government organization, Earnest money deposit (EMD) and Security deposit (SD). Accounting- Terms only- Work Abstract, Cash book, Work register, Accounting for the materials, Measurement book, Muster roll and Record of Bills | CO2 | 2 |
| 5 | **Module V: Total lecture hours: 8** | | |
| 5.1 | Budgetary Control Systems: Types of budgets, new approaches for budgeting, responsibility of accounting, profit centre approach. | CO2, CO5 | 2 |
| 5.2 | Financial Management: Meaning and scope, financial statement analysis, financial ratio analysis, fund flow analysis. | CO2, CO5 | 2 |
| 5.3 | Working Capital Management: Meaning, policy for working capital, estimating working capital needs. Capital investment decision | CO2, CO5 | 2 |
| 5.4 | Long term financing working of financial institutions in India and abroad, self-financing, financing mechanisms. | CO2, CO5 | 2 |

**Model Question Paper**

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

**Course Code: CET453**
**Course Name: CONSTRUCTION PLANNING AND MANAGEMENT**

Marks : 100 Duration : 3 hrs

**PART A**
**(Answer all Questions. Each Question carries 3 Marks)**

1. Differentiate between resource smoothing and resource levelling.
2. List out members of the construction team and write the responsibilities.
3. Explain BIM Technology.
4. What is meant by Organizational Maturity of BIM?
5. Explain Economic Order Quantity.
6. List the important causes of accidents on construction sites.
7. Explain rate of return analysis.
8. What is meant by administrative approval?
9. Discuss any two types of construction budgets.
10. Explain the sources of long-term financing of construction projects.

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

**Module 1**

11. a) Explain the Functions of construction project management.
    b) Describe any two types of organisation structures for construction projects.
12. With an example, explain the procedure for the time-cost tradeoff.

**Module 2**

13. Explain any two labour legislations pertaining to the construction industry.
14. Explain the following
    i) BIM Model
    ii) Clash Detection
    iii) Model Based Cost Estimating
    iv) Dimensions of BIM

**Module 3**

15. Explain the need for Quality assurance and Quality control in construction projects.
16. Discuss in detail ABC analysis for Material Management

**Module 4**

17. a) Give the salient features of the contract document.
    b) Explain any two important conditions of the contract.
18. Discuss the major steps involved in E Tendering and the process of awarding the contract.

**Module 5**

19. Analyse the important benefits of the following:
    i) Fund Flow Analysis
    ii) Financial Ratio Analysis
20. Explain, with examples, the different Methods for Estimating Working Capital Requirement.

| CET463 | ADVANCED ENVIRONMENTAL ENGINEERING | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 | 2019 |

**Preamble:** This course introduces students to the state of technologies that exist for treating water and air. They will learn basic engineering principles that govern these technologies and develop the capacity to select appropriate technologies for solving environmental problems related to water and air pollution.

**Prerequisite:** CET 304 Environmental Engineering

**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 various secondary treatment technologies for waste water | Understand |
| CO2 | Explain various tertiary treatment technologies and their applications | Understand |
| CO3 | Explain engineering principles to dimension various treatment units | Analyse |
| CO4 | Identify appropriate technology for controlling air pollution | Understand |

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

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

**Assessment Pattern**

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

**Mark distribution**

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

**Continuous Internal Evaluation Pattern:**

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

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

**Course Level Assessment Questions**

**CO1: Explain various secondary treatment technologies for waste water**

1.Explain the working principle of a Rotating Biological Contactor.

2. What are the sequential steps of sequencing batch reactor (SBR) operation?

3. Moving bed biofilm reactor (MBBR) is an advanced wastewater treatment technology, which employs the benefits of both biofilm and activated sludge processes. Explain

**CO 2: Explain various tertiary treatment technologies and their applications**

1. What is Fenton process?

2. Discuss the biological removal of phosphorous in waste water.

3. What are the various configurations available for MBR?

**CO3: Explain engineering principles to dimension various treatment units**

1. Calculate the maximum efficiency for a RO plant, which is operated with a inlet pressure of 45 bar and under the condition that effective driving fource $\Delta p_{eff}$ min = 15 bar is maintained. The permeate pressure is 1 bar, pressure loss is 3 bar and mass fraction of salt in permeate (Wp) = 0. Feed is a NaCl solution with mass fraction(Wf) = 0.03 and the osmotic coefficient is 790 bar. How big is the membrane area if 10 $m^3/h$ of permeate are to be produced and a membrane with A = 1,2.10-7 m/(s.bar) was chosen?

2. A design wastewater flow 7571 $m^3/d$ is to be treated with an MBR treatment system. The design membrane module properties are, average membrane flux= 12 $L/hr/m^2$; module packing

density= 120$m^2/m^3$; specific aeration demand= 0.3 $m^3$ air/hr/$m^2$ membrane area. Calculate the required membrane area, membrane module volume and scouring air flow rate.

3. An ESP is collecting 95% of the particles in the waste gas. A salesperson now offers us an additive to add to the gas that will change the resistivity of the collected cake of particles, thus doubling the effective drift velocity. If we use this additive, what will be the improvement in collection efficiency?

**CO4: Identify appropriate technology for controlling air pollution**

1. Compare baghouse filters with cyclone separators in terms of the efficiency of particulate removal from a gas stream.

2. How sulfur oxides can be controlled?

3.Wet scrubbing is useful for the removal of both particulate and gaseous pollutants. Explain

**Syllabus**

**Module 1**

Advances in waste water treatment –Process for biological nitrogen removal –Process for biological phosphorus removal - anoxic-aerobic process design – sequencing batch reactor (SBR)

**Module 2**

Aerobic attached growth Process – Rotating Biological Contactor (RBC), Moving Bed Biofilm Reactor (MBBR)
Advanced Oxidation Processes- Fenton process, Wet Air Oxidation process, Photo-Oxidation process

**Module 3**

Adsorption- Removal of organic and inorganic contaminants- Popular adsorbents-Adsorption Isotherms-Breakthrough Curves in Continuous Adsorption Processes- Adsorption in a Batch Contactor-Adsorption kinetics-Regeneration of spent adsorbents

Ion Exchange-method of purification-Applications in water treatment

**Module 4**

Membrane Technology- Reverse Osmosis (RO)- Ultra Filtration(UF)- Nano Filtration(NF)- Micro Filtration(MF)- Electro Dialysis (ED)-Dimensioning of RO units for desalination.
Tertiary filtration of waste water- design of Membrane Bio Reactors( MBR), MBR configurations.

**Module 5**

Air Pollution Control- Control devices for Particulate pollutants –Cyclone separators, baghouse filters, wet scrubbers, electrostatic precipitators (ESP)- Design of an ESP

Gaseous pollutant control-technologies for the control of sulfur oxides, nitrogen oxides and carbon monoxide- wet scrubbing, process modification.

**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. Gilbert M Masters, Introduction to Environmental Engineering and Science, Pearson Education India; 3rd edition, 2015
4. J. Arceivala, Shyam R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, McGrawhill Education, 2007
5. 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, Wastewater Treatment Plants-Planning, Design & Operation, CRC Press,1999
3. Baker, Membrane Technology and Applications, 3rd ed., Wiley-Blackwell 2012
4. Fane, Schaefer, Waite, Nanoflitration, Principles and applications, Elsevier 2004
5. Peinemann, Nunez, Membrane Technology, 6 vols, Wiley-vch 2007 – 2010


**Course Contents and Lecture Schedule**

| Module | Topic | Course Outcomes addressed | No. of Lectures |
|---|---|---|---|
| **1** | **Module 1: Total Lecture Hours -7** | | |
| 1.1 | Process for biological nitrogen removal-design criteria | CO2 | 2 |
| 1.2 | Process for biological phosphorus removal-design criteria | CO2 | 2 |
| 1.3 | anoxic-aerobic process design – sequencing batch reactor (SBR) | CO1 | 3 |
| **2** | **Module II: Total Lecture Hours- 7** | | |
| 2.1 | Aerobic attached growth Process – Rotating Biological Contactor (RBC) | CO1 | 2 |
| 2.2 | Moving Bed Biofilm Reactor (MBBR) | CO1 | 2 |
| 2.3 | Advanced Oxidation Processes- Fenton process, Wet Air Oxidation process, Photo-Oxidation process | CO2 | 3 |
| **3** | **Module III: Total Lecture Hours-7** | | |
| 3.1 | Adsorption- Removal of organic and inorganic contaminants- Popular adsorbents | CO2 | 1 |
| 3.2 | Adsorption Isotherms | CO2 | 2 |
| 3.3 | Breakthrough Curves in Continuous Adsorption Processes- | CO2 | 2 |

| | | | |
|---|---|---|---|
| | Adsorption in a Batch Contactor- Adsorption kinetics | | |
| 3.4 | Regeneration of spent adsorbents | CO2 | 1 |
| 3.5 | Ion Exchange-method of purification-Applications in water treatment | CO2 | 1 |
| **4** | **Module IV: Total Lecture Hours- 7** | | |
| 4.1 | Membrane Technology- Reverse Osmosis (RO)- Ultra Filtration(UF)- Nano Filtration(NF)- Micro Filtration(MF)- Electro Dialysis (ED) | CO3 | 2 |
| 4.2 | Dimensioning of RO units for desalination | CO3 | 2 |
| 4.3 | Tertiary filtration of waste water- design of Membrane Bio Reactors( MBR), MBR configurations. | CO2, CO3 | 3 |
| **5** | **Module V: Total Lecture Hours- 7** | | |
| 5.1 | Air Pollution Control- Control devices for Particulate pollutants –Cyclone separators, baghouse filters, wet scrubbers, electrostatic precipitators (ESP) | CO4 | 3 |
| 5.2 | Design of an ESP | CO3, CO4 | 1 |
| 5.3 | Gaseous pollutant control-technologies for the control of sulfur oxides, nitrogen oxides and carbon monoxide- wet scrubbing, process modification | CO4 | 3 |

**Model Question Paper**

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

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

**Course Code: CET 463**
**Course Name: ADVANCED ENVIRONMENTAL ENGINEERING**

Max. Marks: 100 Duration: 3 Hours

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

1. Explain denitrification.
2. What are the sequences of operation in an SBR?
3. How advanced oxidation processes (AOP) helps in treating waste water?
4. What is the difference in the biological process of an RBC and MBBR?
5. What are adsorption isotherms?
6. How ion exchange can soften water?
7. What is Ultra filtration?
8. Explain the benefits of MBR treatment system.
9. How cyclones remove particles from a gas stream.
10. what is desulfurization?

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

**Module 1**

11. (a) Explain the process for biological nitrogen removal (9 Marks)

    (b) How anoxic process is different from anaerobic process? (5 Marks)

**OR**

12. (a) Explain the working of an SBR (6 Marks)

    (b) Explain the treatment technologies available for phosphorous removal in waste water (8 Marks)

**Module 2**

13. (a) Explain the working principle of an MBBR (6 Marks)
    (b) Discuss Advanced Oxidation Processes (8 Marks)

**OR**

14. (a) How aerobic attached process compare with aerobic suspended process (5 Marks)
    (b) What is the application of Wet Air Oxidation process (5 Marks)
    (c)How biological process in RBC is different from that in MBBR (4 Marks)

**Module 3**

15. (a) List some popular adsorbents. How they are regenerated after use? (4 Marks)
    (b) Explain breakthrough curve in continuous adsorption process. (5Marks)
    (c) What are the applications of ion exchange process in water treatment? (5 Marks)

**OR**

16. (a) Explain the significance of adsorption processes in environmental engineering (7 Marks)
    (b) Explain various adsorption kinetics models ( 7 Marks)

**Module 4**

17. (a) Explain the working principle of Electro Dialysis (6 Marks)
    (b) Calculate the maximum efficiency for a RO plant, which is operated with a inlet pressure of 45 bar and under the condition that effective driving fource $\Delta p_{eff}$ min = 15 bar is maintained. The permeate pressure is 1 bar, pressure loss is 3 bar and mass fraction of salt in permeate (Wp) = 0. Feed is a NaCl solution with mass fraction(Wf) = 0.03 and the osmotic coefficient is 790 bar. How big is the membrane area if 10 $m^3/h$ of permeate are to be produced and a membrane with A = 1,2.10-7 m/(s.bar) was chosen? (8 marks)

***OR***

18. (a)Explain the working of Membrane Bio Reactors. What are the different configurations available for MBRs? (6 Marks)
    (b) A design wastewater flow 7571 $m^3/d$ is to be treated with an MBR treatment system. The design membrane module properties are, average membrane flux= 12 $L/hr/m^2$; module packing density= $120m^2/m^3$; specific aeration demand= 0.3 $m^3$ air/hr/$m^2$ membrane area. Calculate the required membrane area, membrane module volume and scouring air flow rate. (8 Marks)

**Module 5**

19. (a) Wet scrubbing is useful for the removal of both particulate and gaseous pollutants. Explain (6 Marks)
    (b) As an air pollution control engineer, explain what air pollution control measures you will adopt at a Coal fired thermal power plant and why? (8 Marks)

OR

20. (a) Discuss the source reduction measures for oxides of nitrogen (6 Marks)

(b) Explain the principle of electrostatic precipitator. Discuss the advantages and limitations of electrostatic precipitators. (8 Marks)

| CET473 | OPTIMISATION TECHNIQUES IN CIVIL ENGINEERING | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 | 2019 |

**Preamble:** Optimization techniques in civil engineering is a subject which provide the basic concepts of optimization problem formulation in various civil engineering fields. Optimization has application in all fields of engineering. This course introduces different algorithms for solving structural optimization problems. After this course the students will be able to identify the type of the real-world optimization problems and design the corresponding optimization techniques.

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

| Course Outcome | Description of Course Outcome | Prescribed learning level |
|---|---|---|
| CO1 | Formulate engineering design problem as an optimization problem. | Applying |
| CO2 | Apply suitable optimization technique to the design problem at hand. | Applying |
| CO3 | Evaluate the problem as linear or nonlinear optimization problem and design the optimization technique. | Evaluate |
| CO4 | Evaluate the problem as single variable or multi-variable optimization problem and design the corresponding optimization technique | Evaluate |
| CO5 | Formulate linear programming problem for engineering applications and evaluate the solution. | Evaluate |
| CO6 | Familiarise with transportation and assignment problems and genetic algorithm. | Applying |

**Mapping of course outcomes with programme outcomes**

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

**Assessment Pattern**

| Bloom's Category | Continuous Assessment | | End Semester Examination Marks |
|---|---|---|---|
| | Test 1 Marks | Test 2 Marks | |
| Remember | - | - | |
| Understand | 10 | - | 10 |
| Apply | 10 | 10 | 20 |
| Analysis | 10 | 20 | 30 |
| Evaluate | 20 | 20 | 40 |
| Create | | | |

**Mark distribution**

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

**Continuous Internal Evaluation Pattern:**

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

**End Semester Examination Pattern:**

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

**Course Level Assessment Questions**

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

**Course Outcome 1 (CO1):** Formulate engineering design problem as an optimization problem.

1. Formulate a optimization problem with constraints for determining the optimum dimensions of a simply supported beam of span 6 m subjected to a uniformly distributed load of 30 kN/m. Allowable stress in bending is 10N/mm$^2$ and allowable stress in shear is 1N/mm$^2$. Allowable deflection is span/300.

2. Formulate a optimization problem with constraints for determining the optimal slope and dimensions for the members of the truss if the shape, loads and span are given.

**Course Outcome 2 (CO2):** Apply suitable optimization technique to the design problem at hand.

1. Find the optimum dimensions of a simply supported beam of span 6 m subjected to a uniformly distributed load of 30 kN/m. Allowable stress in bending is $10N/mm^2$ and allowable stress in shear is $1N/mm^2$. Allowable deflection is span/300.

2. Find the optimal slope and dimensions for the members of the truss if the shape, loads and span are given.

**Course Outcome 3 (CO3):** Evaluate the problem as linear or nonlinear optimization problem and design the optimization technique.

1. Calculate the minimum of the given function by unrestricted search, exhaustive search and interval halving methods.

$$f(x) = 0.65 - 0.75/(1+x^2) - 0.65x\tan^{-1}(1/x)$$

2. Using Newton Raphson method find the minimum of the function $f(x) = xe^x - Cosx$

3. Minimize the function by Golden section method and Fibonacci method

$f(x) = 2Sinx - x^2/10$ in the interval (0,10)

**Course Outcome 4 (CO4):** Evaluate the problem as single variable or multi-variable optimization problem and design the corresponding optimization technique.

1. Minimize the function by univariate method

$$f(x_1,x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$$

2. Write down the algorithm for Powell's conjugate direction method

3. Write down the algorithm for Hooke and Jeeve's pattern search method

**Course Outcome 5 (CO5):** Formulate linear programming problem for engineering applications and evaluate the solution.

1. Express the given problem in the standard form

$$Maximize\ z = 3x_1 + 5x_2 + 7x_3 \text{ subject to}$$

$$6x_1 - 4x_2 \leq 5;\ 3x_1 + 2x_2 + 5x_3 \geq 11;\ 4x_1 + 2x_2 \geq 2;\ x_1, x_2 \geq 0$$

2. Determine the minimum value of the objective function

$$Z = -50x + 20y \text{ subject to the constraints}$$

$$2x - y \geq -5 \; ; \; 3x + y \geq 3 \; ; \; 2x - 3y \leq 12 \; ; \; x \geq 0, \; y \geq 0$$

**3.** A dietician has to develop a special diet using two foods P and Q. Each packet (containing 30 g) of food P contains 12 units of calcium, 4 units of iron, 6 units of cholesterol and 6 units of vitamin A. Each packet of the same quantity of food Q contains 3 units of calcium, 20 units of iron, 4 units of cholesterol and 3 units of vitamin A. The diet requires atleast 240 units of calcium, atleast 460 units of iron and at most 300 units of cholesterol. How many packets of each food should be used to minimise the amount of vitamin A in the diet? What is the minimum amount of vitamin A?

**Course Outcome 6 (CO6):** Familiarise with transportation and assignment problems and genetic algorithm

1. There are two factories located one at place P and the other at place Q. From these locations, a certain commodity is to be delivered to each of the three depots situated at A, B and C. The weekly requirements of the depots are respectively 5, 5 and 4 units of the commodity while the production capacity of the factories at P and Q are respectively 8 and 6 units. The cost of transportation per unit is given below:

| From/To | Cost in (Rs) | | |
|---|---|---|---|
| | A | B | C |
| P | 160 | 100 | 150 |
| Q | 100 | 120 | 100 |

How many units should be transported from each factory to each depot in order that the transportation cost is minimum. What will be the minimum transportation cost?

**2.** A company manufactures two products P1 and P2. The company has two types of machines A and B. Product P1 take 2 hours on machine A and 4 hours on machine B, whereas product P2 takes 5 hours on machine A and 2 hours on machine B. The profit realised on the sale of one unit of product P1 is Rs.3 and that of product P2 is Rs. 4. If machine A and B can operate 24 and 16 hours per day respectively, determine the weekly out put for each product in order to maximise the profit. (Assume a 5day week).

## Syllabus

**Module -1**

Introduction to optimization methods- optimization problem formulation - objective function, constraints. Classification of optimization problems. Geometric, graphical, analytical methods of optimization. Application examples from engineering.

**Module -2**

Single Variable Unconstrained Optimisation Techniques- Optimality Criteria. Bracketing methods: Unrestricted search, Exhaustive search. Region Elimination methods: Interval Halving methods, Dichotomous search, Fibonacci method, Golden section method. Interpolation methods: Quadratic Interpolation method, Cubic Interpolation method. Gradient Based methods: Newton-Raphson method, Secant method, Bisection method.

**Module -3**

Multivariable Unconstrained Optimisation Techniques- Optimality Criteria- Unidirectional Search. Direct Search methods: Random search, Grid search, Univariate method, Hooke's and Jeeves' pattern search method, Powell's conjugate direction method, Simplex method. Gradient based methods: Cauchy's (Steepest descent) method, Conjugate gradient (Fletcher Reeves) method, Newton's method, Variable metric (DFP)method, BFGS method.

**Module -4**

Linear programming, simplex method- dual problem, weak duality theorem, optimality criterion theorem, main duality theorem, complementary slackness theorem, primal-dual relationship, economic interpretation of dual solution, introduction to sensitivity analysis examples of applications of linear programming in engineering.

**Module -5**

Transportation problem- Assignment problem- applications of linear programming problems in Civil Engineering- Introduction to Genetic Algorithms- basic concept- problem formulation - operations- convergence criteria.

**Text Books:**

1. Rajasekharan S. "Numerical Methods in Science and Engineering" S Chand & company 2003.
2. S.S. Rao, Optimisation Theory and applications, Wiley Eastern.
3. Belegundu., Optimisation concepts and Applications Engineering.
4. S. S. Rao, Engineering Optimization, New Age International (P) Ltd. Publishers.
5. J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company.
6. K. Deb, Multiobjective Optimization using Evolutionary Algorithms, John Wiley and Sons.

**Reference Books:**


1. Grewal B.S. "Numerical Methods in Engineering and Science" Khanna Publishers.
2. Chapra S.C. and Canale R.P. "Numerical Methods for Engineers" Mc Graw Hill 2006.
3. Ketter and Prawel "Modern Methods for Engineering Computations" Mc Graw Hill
4. Terrence. J. Akai "Applied Numerical Methods for Engineers", Wiley publishers 1994.
5. R.L. Fox, Optimisation methods in Engineering Design, Addison Wesely
6. Ravindran, D. T. Phillips, J. J. Solberg, Operations Research – Principles and Practice, John Wiley and Sons.
7. Ravindran, K. M. Ragsdell, G. V. Reklaitis, Engineering Optimization – Methods and Applications, John Wiley and Sons.
8. M. S. Bazaraa, H. D. Sherali, and C. M. Shetty, Nonlinear Programming: Theory and Algorithms, Wiley-Interscience.
9. Rajasekharan S. "Numerical Methods for Initial and Boundary value problems," Khanna publishers 1989.


| Module | Contents | Course Outcomes addressed | No. of Lectures |
|---|---|---|---|
| **1** | **Module 1: Total lecture hours:7** | | |
| 1.1 | Introduction to optimization methods | 1 | 1 |
| 1.2 | Problem formulation, objective function, constraints | 1 | 1 |
| 1.3 | Classification of optimization problems. | 1 | 1 |
| 1.4 | Geometric methods of optimization | 2 | 1 |
| 1.5 | Graphical methods of optimization | 2 | 1 |
| 1.6 | Analytical methods of optimization | 2 | 1 |
| 1.7 | Application examples from engineering. | 1 | 1 |
| **2** | **Module 2: Total lecture hours: 6** | | |
| 2.1 | Single Variable Unconstrained Optimisation Techniques, Optimality Criteria. | 3, 4 | 1 |
| 2.2 | Bracketing methods: Unrestricted search, Exhaustive search. | 3, 4 | 1 |

| | | | |
|---|---|---|---|
| 2.3 | Region Elimination methods: Interval Halving methods, Dichotomous search | 3, 4 | 1 |
| 2.4 | Fibonacci method, Golden section method | 3, 4 | 1 |
| 2.5 | Interpolation methods: Quadratic Interpolation method, Cubic Interpolation method. | 3, 4 | 1 |
| 2.6 | Gradient Based methods: Newton-Raphson method, Secant method, Bisection method | 3, 4 | 1 |
| **3** | **Module 3: Total lecture hours: 8** | | |
| 3.1 | Multivariable Unconstrained Optimisation Techniques | 3, 4 | 1 |
| 3.2 | Optimality Criteria- Unidirectional Search. | 3, 4 | 1 |
| 3.3 | Direct Search methods: Random search, Grid search | 3, 4 | 1 |
| 3.4 | Univariate method, Hooke's and Jeeves' pattern search method | 3, 4 | 1 |
| 3.5 | Powell's conjugate direction method, Simplex method | 3, 4 | 1 |
| 3.6 | Gradient base methods: Cauchy's (Steepest descent) method, | 3, 4 | 1 |
| 3.7 | Conjugate gradient (Fletcher Reeves) method | 3, 4 | 1 |
| 3.8 | Newton's method, Variable metric (DFP)method, BFGS method. | 3, 4 | 1 |
| **4** | **Module 4: Total lecture hours: 8** | | |
| 4.1 | Linear programming, simplex method | 5 | 1 |
| 4.2 | Dual problem, weak duality theorem | 5 | 1 |
| 4.3 | Optimality criterion theorem, main duality theorem | 5 | 1 |
| 4.4 | Complementary slackness theorem | 5 | 1 |
| 4.5 | Primal-dual relationship, economic interpretation of | 5 | 1 |

| | | | |
|---|---|---|---|
| | dual solution | | |
| 4.6 | Introduction to sensitivity analysis | 5 | 1 |
| 4.7 | Examples of applications of linear programming in engineering. | 5 | 1 |
| 4.8 | Numerical Examples | 5 | 1 |
| **5** | **Module 5: Total lecture hours: 6** | | |
| 5.1 | Transportation problem | 6 | 1 |
| 5.2 | Assignment problem | 6 | 1 |
| 5.3 | Numerical Examples | 6 | 1 |
| 5.4 | Applications of linear programming problems in Civil Engineering | 6 | 1 |
| 5.5 | Introduction to Genetic Algorithms, Basic concept - problem formulation | 6 | 1 |
| 5.6 | Operations- convergence criteria. | 6 | 1 |

**Model Question Paper**

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

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

**Course Code:CET473**

**Course Name: OPTIMISATION TECHNIQUES IN CIVIL ENGINEERING**

Max. Marks: 100 Duration: 3 hours

**Part A**

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

1. What is the difference between a bound point and a free point in the design space?
2. What is graphical optimisation and what are its limitations?
3. What is the basis of the interval halving method?
4. What is the difference between quadratic and cubic interpolation methods?
5. Give three reasons why the study of unconstrained minimization methods is important.
6. Why is Powell's method called a pattern search method?
7. State an LPP problem in standard form.
8. Why is linear programming important in several types of industries?
9. How can we represent a standard genetic algorithm?
10. Explain the cycle of genetic algorithm.

**PART B**

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

11. (a) . Explain the general steps involved in formulation of optimisation model (6 Marks)

    (b) A uniform column of rectangular cross section is to be constructed for supporting a water tank of mass M. It is required (1) to minimize the mass of the column for economy, and (2) to maximize the natural frequency of transverse vibration of the system for avoiding possible resonance due to wind. Formulate the problem of designing the column to avoid failure due to direct compression and buckling. Assume the permissible compressive stress to be $\sigma_{max}$. (8 Marks)

OR

12. (a) State any six engineering applications of optimization. (6 Marks)

(b) Formulate a optimization problem with constraints for determining the optimum dimensions of a simply supported beam of span 6 m subjected to a uniformly distributed load of 30 kN/m. Allowable stress in bending is 10N/mm2 and allowable stress in shear is 1N/mm2. Allowable deflection is span/300. (8 Marks)

13. Find the minimum of the following function using Newton Raphson method with the starting point $x_1 = 0.1$. $f(x) = 0.65 - 0.75/(1+x^2) - 0.65x\tan^{-1}(1/x)$ (14 marks)

**OR**

14. (a) What is the difference between Fibonacci and golden section methods? (6 Marks)

(b) Find the minimum of f = x(x - 1.5) in the interval (0.0,1.00) to within 10% of the exact value by exhaustive search method (8 Marks)

15. (a) Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ with the starting point (0,0) by Hooke and Jeeves method (14 Marks)

**OR**

16. (a) Show that the DFP method is a conjugate gradient method. (7 Marks)

(b) Prove that the gradient vector represents the direction of steepest ascent. (7 marks)

17. (a) Maximise $F = x_1 + 2x_2 + x_3$ subject to

$$2x_1 + x_2 - x_3 \leqslant 2$$
$$-2x_1 + x_2 - 5x_3 \geqslant 6$$
$$4x_1 + x_2 + x_3 \leqslant 6$$
$$x_i \geqslant 0,\ i = 1,2,3$$

(14 Marks)

**OR**

18. A dietician has to develop a special diet using two foods P and Q. Each packet (containing 30 g) of food P contains 12 units of calcium, 4 units of iron, 6 units of cholesterol and 6 units of vitamin A. Each packet of the same quantity of food Q contains 3 units of calcium, 20 units of iron, 4 units of cholesterol and 3 units of vitamin A. The diet requires atleast 240 units of calcium, atleast 460 units of iron and at most 300 units of cholesterol. How many packets of each food should be used to minimise the amount of vitamin A in the diet? What is the minimum amount of vitamin A?
(14 Marks)

19. There are two factories located one at place P and the other at place Q. From these locations, a certain commodity is to be delivered to each of the three depots situated at A, B and C. The weekly requirements of the depots are respectively 5, 5 and 4 units of the commodity while the production capacity of the factories at P and Q are respectively 8 and 6 units. The cost of transportation per unit is given below:

| From/To | Cost in (Rs) | | |
|---|---|---|---|
| | A | B | C |
| P | 160 | 100 | 150 |
| Q | 100 | 120 | 100 |

How many units should be transported from each factory to each depot in order that the transportation cost is minimum. What will be the minimum transportation cost?

(14 marks)

**OR**

20. A company manufactures two products P1 and P2. The company has two types of machines A and B. Product P1 take 2 hours on machine A and 4 hours on machine B, whereas product P2 takes 5 hours on machine A and 2 hours on machine B. The profit realised on the sale of one unit of product P1 is Rs.3 and that of product P2 is Rs. 4. If machine A and B can operate 24 and 16 hours per day respectively, determine the weekly out put for each product in order to maximise the profit. (Assume a 5day week).

(14 marks)

| CET415 | ENVIRONMENTAL IMPACT ASSESSMENT | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | OEC | 2 | 1 | 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 to

| Course Outcome | Description of Course Outcome | Prescribed learning level |
|---|---|---|
| CO1 | Explain the need for minimizing the environmental impacts of developmental activities | Understand |
| CO2 | Outline environmental legislation & clearance procedure in the country | Remember, Understand |
| CO 3 | Apply various methodologies for assessing the environmental impacts of any developmental activity | Apply & Analyse |
| CO 4 | Prepare an environmental impact assessment report | Analy & Evaluate |
| CO 5 | Conduct an environmental audit | Analyse & Evaluate |

**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: Explain 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: Outline the 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: 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: 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: 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 impacts and Socio economic Impacts.

**Module 4**

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

**Module 5**

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

**Text Books:**

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

**References:**


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


**Course Contents and Lecture Schedule**

| 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**

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION

**Course Code: CET415**

**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)***

**Module 1**

11. (a) Discuss environmental standards for water, air and noise (6 Marks)
    (b) Discuss evolution of EIA in India (8 Marks)

OR

12. (a) Discuss Air (Prevention & Control of Pollution) Act 1981 (5 Marks)
    (b) Explain salient features of EIA notification 2006 (9 Marks)

**Module 2**

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)

**Module 3**

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

**Module 4**

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)

**Module 5**

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)

| CET425 | APPLIED EARTH SYSTEMS | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | OEC | 2 | 1 | 0 | 3 | 2019 |

**Preamble:** Objective of the course is to appreciate the concept of earth system and it interrelated components, the processes and mechanisms thereof.

**Prerequisite:** Nil

**Course Outcomes:**

| | |
|---|---|
| CO 1 | Explain the concept of earth as a system of interrelated components and associated exogenic/endogenic processes. |
| CO 2 | Appraise geological agents and their respective erosion, transportation and deposition regimes and landforms formed. |
| CO 3 | Contemplate constraints and processes that continuously affect earth's surface and its stability and consistency. |
| CO 4 | Evaluate/investigate the significance of Plate tectonics theory to explain the geodynamic features and processes of earth's surface. |
| CO 5 | Develop an understanding of oceanographic and atmospheric regimes and their sway on other subsystems and process thereof. |
| CO 6 | Understand implications of human interaction with the Earth system. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | | 2 | | 3 | 3 | 2 | | | | 3 | | |
| **CO 2** | 3 | 3 | | 3 | | 3 | 3 | | 1 | | | 3 | | |
| **CO 3** | 3 | 3 | | 3 | | 3 | 3 | 2 | 1 | | 3 | 3 | | |
| **CO 4** | 3 | 3 | | 3 | | 3 | 3 | | | | | 3 | | |
| **CO 5** | 3 | 3 | 2 | 3 | | 3 | 3 | | | | | 3 | | |
| **CO 6** | 2 | 3 | | 2 | | 3 | 3 | 3 | | | | 3 | | |

**Assessment Pattern**

| Bloom's Category | Continuous Assessment | | End Semester Examination (marks) |
|---|---|---|---|
| | Test 1 Marks | Test 2 Marks | |
| Remember | 3 | 3 | 10 |
| Understand | 4 | 4 | 15 |
| Apply | - | - | - |
| Analyse | 9 | 9 | 37 |
| Evaluate | 9 | 9 | 38 |
| 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:**

1 **Course Outcome 1 (CO1):**
Explain, citing examples the subsystems of earth interact with each other.

**2 Course Outcome 2 (CO2):**
Appraise the processes involved in any erosional or depositional feature of rivers.

**3 Course Outcome 3 (CO3):**
Discuss the controls that give rise to mass movements.

**4 Course Outcome 4 (CO4):**
Analyse the distribution of seismicity and volcanism with respect to plate dynamics.

**5 Course Outcome 5 (CO5):**
Examine ecological significance of coral reefs and implications of global warming on them.

**6 Course Outcome 6 (CO6):**

Assess the effect of human activities enhance the vulnerability of environment.

**Syllabus**

| Module | Contents | Hours |
|---|---|---|
| I | Fundamental concepts of equilibrium. Geomorphic agents and processes. Basic concept of Earth as a system and its component sub systems. Climate Change vis-a-vis the interrelationships of the subsystems | 5 |
| II | Weathering- relevance, influence of and on earth systems, types and controlling factors<br>Fluvial processes-hydrological cycle, fluvial erosion, transportation and deposition, fluvial landforms. Stages of stream development; Drainage patterns. | 6 |
| III | Soil- formation and controls, soil profile, soil erosion and conservation methods.<br>Deserts-distribution and controls. | 7 |
| IV | Wagner's ideas of continental drift, Plate Tectonics- seafloor spreading. Plate boundaries and their features, mechanisms of plate movements. | 6 |
| V | Basics of oceanography: coastal upwelling and downwelling. Outlines of ocean floor topography, Brief account of marine sediments, turbidity currents, basic outlines of origin and circulation of deep-sea surface currents (Atlantic and Pacific Oceans), coral reefs- types and concepts about their formation.<br>Basics of atmosphere and atmospheric processes: Structure and composition of the atmosphere. Heat budget, factors affecting solar radiation. Green House Effect and Global warming, basic ideas about their causes and effects | 12<br>(6+6) |

**Text/Reference Books**

1. Critchfield H. General Climatology Prentice Hall, New Delhi, 1983

2. Fetter C. Applied Hydrogeology CBS New Delhi, 1990

3. Carlson, DH, Plummer, CC and McGreary, D Physical geology: Earth Revealed McGraw Hill New York, 2006

4. Pinet PR Oceanography – An Introduction to the Planet Oceanus, West Publishing Co, 1992

5. Ritter, DF, Kochel, RC and Miller, JR. Process Geomorphology Wm.C. Brown Publishers New York, 1995

6. Soman K Geology of Kerala Geological Society of India, Bangalore, 2001

**Course Content and lecture Schedule:**

| No. | Topic | Course Outcome | Hours |
|---|---|---|---|
| | **Module I** | | |
| 1.1 | Basic concept of Earth as a system, interactions between its component sub systems. | CO1, CO5, CO6 | 1 |
| 1.2 | Fundamental concepts of equilibrium | CO1, CO3 | 2 |
| 1.3 | Geomorphic agents and processes | CO1, CO2, CO3 | 2 |
| | **Module II** | | |
| 2.1 | Weathering- relevance, influence of and on earth systems Types and controlling factors | CO1, CO2, CO3 | 2 |
| 2.2 | River as a system, Fluvial processes-hydrological cycle, fluvial erosion, transportation and deposition and landforms | CO1, CO2, CO3 | 2 |
| 2.3 | Stages of stream development | CO1, CO2, CO3 | 1 |
| 2.4 | Drainage patterns and implications | CO1, CO2, CO3, CO4 | 1 |
| | **Module III** | | |
| 3.1 | Soil- significance and controls, soil profile | CO1, CO2, CO3, CO6 | 2 |
| 3.2 | Soil erosion and conservation methods | CO1, CO2, CO3, CO6 | 3 |
| 3.3 | Deserts-distribution and controls | CO2, CO3 | 2 |
| | **Module IV** | | |
| 4.1 | Wagner's ideas of continental drift, limitations | CO2, CO3, CO4 | 2 |
| 4.2 | Plate Tectonics- background of the theory, evidences | CO2, CO3, CO4 | 1 |
| 4.3 | Plate boundaries and their features, seismicity and volcanism | CO2, CO3, CO4 | 2 |
| 4.4 | vis-à-vis plates Mechanisms of plate movements | CO2, CO3, CO4 | 1 |
| | **Module V** | | |
| 5.1 | Importance of marine environment | CO1, CO2, CO3 | 1 |
| 5.2 | Circulation in oceans- surface circulation in deep sea (Atlantic and Pacific Oceans), coastal upwelling and downwelling | CO1, CO2, CO3 | 2 |
| 5.3 | Outlines of ocean floor topography, brief account of marine | CO1, CO2, CO3 | 2 |
| 5.4 | sediments Turbidity currents | CO1, CO2, CO3 | 1 |
| 5.5 | Coral reefs- types and concepts about their formation. | CO1, CO2, CO3 | 2 |
| 5.6 | Structure and composition of the atmosphere | CO1, CO2, CO3, CO6 | 2 |
| 5.7 | Heat budget, radiation balance of earth, Green House Effect and Global warming, basic ideas about their causes and effects | CO1, CO2, CO3, CO6 | 2 |

**Model Question Paper**

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
**SEVENTH SEMESTER B.TECH DEGREE EXAMINATION**
**Course Code: CET425**
**APPLIED EARTH SYSTEMS**

Marks:100 Duration: 3 hours

**PART A**
**(Answer all questions. Each question carries three marks)**

1. Natural slopes are in dynamic equilibrium. Appraise.
2. Assess the significance of different soil horizons.
3. Examine the conditions that give rise to parallel drainage pattern.
4. Describe features associated with convergent plate boundaries.
5. Assess the fossil evidences that support the idea of continental drift.
6. Compare creep and solifluction.
7. Assess the conditions of coral bleaching.
8. Appraise the increasing temperature with elevation in stratosphere.
9. Evaluate the role of latitudinal distribution in the formation of Hadley cells.
10. Explain the role of ocean currents in the formation of deserts.

**PART B**

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

**MODULE 1**

11. There are mass and energy interactions between the subsystems of earth. Justify with two examples. (14)

**OR**

12. Assess the feedback mechanisms involved in controlling the mean sea-level. (14)

**MODULE 2**

13. Evaluate the controls (any four) on chemical weathering. (14)

**OR**

14. Examine the processes of fluvial erosion and transportation. (14)

**MODULE 3**

15. Evaluate the factors giving rise to aridity. (14)

**OR**

16. Discuss the influence of climate, slope and rock structure on occurrence on soil genesis. (14)

**MODULE 4**

**17.** a) Examine any two evidences put forth by Wagner that support continental drift. (8)

b) Relate convection currents in mantle to plate movements. (6)

**OR**

18. Appraise the significance of plate boundaries on seismicity and volcanism. (14)

**MODULE 5**

19. a) Explain the implications of ozone, water vapour and carbon dioxide in troposphere. (7)

b) How are turbidity currents formed? (7)

**OR**

20. a) Examine the heat budget of earth. (7)

b) Assess the significance of zooxanthellae in the maintenance of coral reefs. (7)

| CET435 | INFORMATICS FOR INFRASTRUCTURE MANAGEMENT | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | OEC | 2 | 1 | 0 | 3 | 2019 |

**Preamble:** This course is aimed at exposing the students to the scope of Informatics and Internet of Things (IoT) in Civil Engineering. It introduces students to the fundamentals of data analytics, informatics &IoT as it is applicable to civil engineering field. After this course, students will be in a position to appreciate the use of informatics & IoT in civil engineering projects and follow the future developments in this sector.

**Prerequisite:** NIL

**Course Outcomes:**

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

| Course Outcome | Description of Course Outcome | Prescribed learning level |
|---|---|---|
| CO 1 | Explain the fundamental concepts of data science, informatics & internet of things | Remembering, Understanding |
| CO 2 | Identify the use of geomatics in planning and site selection of infrastructure projects | Applying & Analysing |
| CO 3 | Apply building informatics in construction, monitoring and project management | Applying& Analysing |
| CO4 | Utilize IoT technology in infrastructure management | Applying& Analysing |

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

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

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

**Course Outcome 1 (CO1):**

*Explain the fundamental concepts of data science, informatics & internet of things.*

1. Explain DIKW pyramid.
2. Explain the data mining techniques
3. Discuss different data models
4. Discuss the vector data analysis techniques
5. Explain COBie standard

6. List IoT protocols
7. What are the elements of BIM?

**Course Outcome 2 (CO2):**

*Identify the use of geomatics for planning and site selection of infrastructure projects.*

1. Discuss how geomatics help in site selection of a solid waste management facility
2. Discuss how terrain modeling is an important geographic information for project planning

**Course Outcome 3 (CO3):**

*Apply building informatics in construction, monitoring and project management.*

1. How BIM helps inreducing the cost of construction?
2. Discuss the steps in developing a BIM for an infrastructure project.

**Course Outcome 4 (CO4):**

*Utilise IoT technology in infrastructure management.*

1. How a water supply system could benefit by IoT technology?
2. Monitoring infrastructure projects could leverage from IoT technologies! Discuss.

**Syllabus**

**Module 1**

**Data to Information**

History of informatics, DIKW pyramid, data management- data types, Meta data, database management systems; Data analysis techniques-spatial and non-spatial data, trends and patterns

**Module 2**

**Geoinformatics**

Fundamental concepts in Geo-informatics- Components, Spatial data and attributes, vector and raster data models, Vector data analysis-buffering, overlay; Raster data analysis- local operations, neighborhood operations, zonal operations

**Module 3**

**Planning and Site selection**

Application of geoinformatic systems: Site suitability analysis- Residential area, Industrial area and a Reservoir. Zoning- Ground water potential zonation, Hazard zonation

Network Analysis- Water supply line, Power line and a Road network

**Module 4**

**Building Informatics**

Building Information Modelling- Definition, Elements of BIM, steps in BIM development, COBie standard, potential and applications of BIM

**Module 5**

**Internet of Things (IoT) in Civil Infrastructure**

IoT Standards & Protocols, Concept of IoT in civil engineering- Applications in construction, product monitoring and project Management

Management Applications- Traffic Regulation, Water Supply and Smart Buildings

**Text Books**


1. J. Campbell, Essentials of Geographic Information Systems, Saylor Foundation, 2011.
2. RamezElmasri, ShamkantB.Navathe, "Fundamental of Database Systems", Pearson Addison Wesley, 2003.
3. BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, Publisher: John Wiley & Sons; 2nd edition (1 July 2011), Language: English, ISBN-10: 9780470541371


**Reference Books**


1. Raja R. A. Issa and Svetlana Olbina,Building Information Modeling: Applications and Practices, ASCE, 2015.
2. Samuel Greengard, The internet of things, The MIT Press Essential Knowledge Series, 2015, ISBN: 978-0-262-52773-6.
3. ShashiShekhar and Sanjay Chawla,"Spatial Databases:A Tour", Prentice Hall, 2003.
4. Building Information Modeling: BIM in Current and Future Practice, Publisher: John Wiley & Sons; 1 edition (15 August 2014), Language: English, ISBN-10: 9781118766309

**Course Contents and Lecture Schedule**

| Module | Topic | Course outcomes addressed | No. of Lectures |
|---|---|---|---|
| **1** | **Module I : Total lecture hours : 7** | | |
| 1.1 | History of informatics | CO1 | Lecture 1 |
| 1.2 | DIKW pyramid& Meta data | CO1 | Lecture 2 |
| 1.3 | Data management | CO1 | Lecture 3 |
| 1.4 | Data types & Meta data | CO1 | Lecture 4 |
| 1.5 | Database management systems | CO1 | Lecture 5 |
| 1.6 | Data analysis techniques | CO1 | Lecture 6 |
| 1.7 | Trends & Patterns in data analysis | CO1 | Lecture 7 |
| **2** | **Module II : Total lecture hours : 7** | | |
| 2.1 | Fundamental concepts in Geo-informatics- | CO1 | Lecture 1 |
| 2.2 | Components of GIS | CO1 | Lecture 2 |
| 2.3 | Spatial data and attributes | CO1 | Lecture 3 |
| 2.4 | Data models- vector & raster | CO1 | Lecture 4 |
| 2.5 | Vector data analysis | CO1 | Lecture 5 |
| 2.6 | Raster data analysis- local & neighbourhood analysis | CO1 | Lecture 6 |
| 2.7 | Raster data analysis- zonal analysis | CO1 | Lecture 7 |
| **3** | **Module III : Total lecture hours : 7** | | |
| 3.1 | Site suitability analysis for Residential area | CO2 | Lecture 1 |
| 3.2 | Site suitability analysis for Industrial area | CO2 | Lecture 2 |
| 3.3 | Site suitability analysis for reservoir | CO2 | Lecture 3 |
| 3.4 | Ground water potential zonation& Hazard zonation mapping | CO2 | Lecture 4 |
| 3.5 | Network analysis for water supply | CO2 | Lecture 5 |
| 3.6 | Network analysis for power line | CO2 | Lecture 6 |

| | | | |
|---|---|---|---|
| 3.7 | Network analysis for road network | CO2 | Lecture 7 |
| **4** | **Module IV : Total lecture hours : 7** | | |
| 4.1 | Building Information Modelling- Definition | CO3 | Lecture 1 |
| 4.2 | Elements of BIM | CO3 | Lecture 2& 3 |
| 4.3 | Steps in BIM development | CO3 | Lecture 4 & 5 |
| 4.4 | COBie standard | CO3 | Lecture 6 |
| 4.5 | Potential & applications of BIM | CO3 | Lecture 7 |
| **5** | **Module V : Total lecture hours : 7** | | |
| 5.1 | IoT Standards & Protocols, Concept of IoT in civil engineering | CO4 | Lecture 1 |
| 5.2 | Application of IoT in construction, product monitoring & project management | CO4 | Lecture 2,3 & 4 |
| 5.3 | Management applications of IoT- Traffic, water supply, smar buildings | CO4 | Lecture5,6 & 7 |

**Model Question Paper**

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

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

**Course Code: CET 435**

**Course Name: INFORMATICS FOR INFRASTRUCTURE MANAGEMENT**

Max. Marks: 100 Duration: 3 hours

**Part A**

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

1. Explain different data types.
2. Explain DIKW pyramid.
3. Compare vector & raster model.
4. What are the components of GIS?
5. Explain network analysis.
6. What is the importance of terrain modeling?
7. Define BIM.

8. What is COBie standard?
9. List the IoT protocols.
10. Explain the concept of smart buildings.

## PART B

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

11. (a) Discuss data analysis techniques for spatial data. (5 Marks)

    (b) Explain the steps in processing data into information. (9 Marks)

OR

12. (a) Briefly describe the history of informatics (5 Marks)

    (b) Explain various data analysis techniques. (9 Marks)

13. (a) Discuss various components of GIS (5 Marks)

    (c) Explain various vector analysis techniques. (9 Marks)

OR

14. (a) Explain buffering analysis. What is its application? (5 Marks)

    (b) Explain various raster data analysis techniques. (9 Marks)

15. (a) How the site suitability analysis is carried out for a reservoir? (7 Marks)

    (b) Explain how geomatics is useful for mapping hazard zones. (7 Marks)

OR

16. (a) Explain the methodology for road network analysis. (7 Marks)

    (b) Explain the process of converting data to information for a industrial area selection. (7 Marks)

17. (a) What are the applications of BIM? (5 Marks)

    (b) Discuss the steps in developing a BIM for an infrastructure project.(9 marks)

OR

18. (a) Explain the elements of BIM. (5 Marks)

    (b) How BIM helps in reducing the cost of construction? (9 Marks)

19. (a) What sensors & devices would help in monitoring water distribution network. (5 Marks)

    (b) Infrastructure management could leverage from IoT technologies! Discuss. (9 Marks)

OR

20. (a) What are the selection criteria for sensors & devices used in IoT technologies. (7 Marks)

(b) Discuss how IoT technologies could help in traffic management. (7 Marks)

| CET445 | NATURAL DISASTERS AND MITIGATION | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | OEC | 2 | 1 | 0 | 3 | 2019 |

**Preamble** : Objective of the course is to introduce the concept of disasters, their causes and their mitigation and management.

**Prerequisite:** Nil

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

| | |
|---|---|
| CO 1 | Explain interaction between subsystems of earth that give rise to hazards and their potential for disasters |
| CO 2 | Explain the evolving concepts and thoughts of management of hazards and disasters |
| CO 3 | Analyse the causes behind natural disasters and evaluate their magnitude and impacts |
| CO 4 | Create management plans for hazards and disasters, and understand the roles of agencies involved. |
| CO 5 | Explain the concept of sustainable development and EIA and their role in mitigating disasters |

**Mapping of course outcomes with program outcomes**

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

**Assessment Pattern**

| Bloom's Category | Continuous Assessment | | End Semester Examination (marks) |
|---|---|---|---|
| | Test 1 Marks | Test 2 Marks | |
| Remember | 5 | 5 | 20 |
| Understand | 5 | 5 | 20 |
| Apply | - | - | - |
| Analyse | 5.5 | 5.5 | 22 |
| Evaluate | 5.5 | 5.5 | 22 |
| Create | 4 | 4 | 16 |

**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 3marks 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:**
Citing a few examples known to you, discuss how disaster differs from a hazard.

**Course Outcome 2 :**
Compare a few earthquakes in history based on their magnitude and degree of damage.

**Course Outcome 3:**
Discuss how the potentiality for volcanic eruption may be assessed.

**Course Outcome 4:**
Based on any disaster in an infrastructure project, prepare a report on how following EIA rules could have abated the disaster.

**Course Outcome 5:**
Prepare a disaster management plan in case of a landslide on a Railway track near to a station.

## Syllabus

| Module | Contents | Hours |
|---|---|---|
| **1** | Hazards and disasters: Introduction to key concepts and terminology: hazard, disasters and types of classifications, vulnerability, exposure, risk, crisis, emergency, capacity, resilience, Carbon footprint. Effect of subsystems of earth. Urbanisation, hazards and disasters. | 3 |
| **2** | Extent and nature of natural hazards, implications of climate change: Earth quakes, Volcanoes, Floods. Coastal disasters- Storm surges, Tsunamis, mitigation methods. | 8 |
| **3** | Landslides, Soil and soil degradation, erosion and Desertification, Forest fires, their mitigation methods. | 7 |
| **4** | Impacts and assessment: Risk Management and Assessment and Disaster Management cycle. SWOT Analysis- basic concepts, uses, limitations and advantages. Disaster management plan and reports, participation of community in disaster management. | 8 |
| **5** | Hazard and disaster management plans for floods, storm surges, landslides, earthquakes, forest fires: pre-disaster phase, actual disaster phase, post-disaster phase- Relief and Amenities, Relief camps, organization, individual and community participation, camp layout, food requirement, water needs, sanitation, security, information administration. Concepts of EIA and sustainable development. Technology in disaster management. | 9 |

**Text Books**


1. Ariyabandu, M. and Sahni P. “Disaster Risk Reduction in South Asia”, Prentice-Hall (India), 2003.
2. Valdiya, K.S. “Environmental Geology - Ecology, Resource and Hazard Management”. McGraw-Hill Education (India) Private Limited. 2013
3. Shaw, R and Krishnamurthy, RR (Ed.) “Disaster Management: Global Problems and Local Solutions”. Universities Press (India) Ltd. 2009
4. Gupta, H.K. (Ed.), “Disaster management”. Universities Press (India) Ltd. 20038.
5. Jha, M.K. (Ed.) “Natural and Anthropogenic Disasters- Vulnerability, Preparedness and Mitigation”. Springer, Amsterdam. 2010
6. Nick Carter. W., “Disaster Management - A Disaster Manager's Handbook”. Asian Development Bank, Philippines. 1991
7. U.N.O, “Mitigating Natural Disasters, Phenomena, Effects and options, A Manual for policy makers and planners”, United Nations. New York, 1991

**References**


1. Andrew, S., "Environmental Modeling with GIS and Remote Sensing", John Willey, 2002
2. Bell, F.G., "Geological Hazards: Their assessment, avoidance and mitigation", E & FN SPON Routledge, London. 1999
3. Bossler, J.D., "Manual of Geospatial Science and Technology", Taylor and Francis, 2001
4. Alexander, D., "Natural Disasters", Research Press, New Delhi, 1993
5. Girard, J. "Principles of Environmental Chemistry". Jones & Bartlett Publishers,New York. 2013
6. Khorram-Manesh, A. (Ed.). "Handbook of Disaster and Emergency Management". Kompendiet (Gothenburg). 2017
7. Mason, I., McGuire, B., and Kilburn, C., "Natural Hazards and Environmental Change (Key Issues in Environmental Change)". Routledge, London. 2002


**Model Question Paper**

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

**Course Code: CET445**
**Course Name: NATURAL DISASTERS & MITIGATION**

Marks:100 Duration: 3 hours

**PART A**
**(Answer all questions. Each question carries three marks)**

1. With a typical example explain how a hazard differs from a disaster
2. Explain the terms: vulnerability and risk and how they contribute to disasters
3. Enumerate natural disasters, and mention their impacts.
4. How are earthquakes caused? What is the connection between earthquake and tsunami?
5. How is soil formed? Why do soils differ in characteristics?
6. Compare creep and solifluction.
7. What is meant by a pre-disaster plan? Give an example.
8. How is environmental impact connected to disasters?
9. Evaluate the pre-disaster measures for landslides.
10. Compare risk and vulnerability assessment.

**PART B**

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

11. a) Describe how an infrastructure project could trigger disaster. (6)
    b) How does resilience influence the recovery from a disaster? Illustrate with examples. (8)

**OR**

12. Bring out the differences between emergency and disaster. How is the risk for a disaster assessed? (14)
13. What are the causes of floods? How do they decide the magnitude of impact? (14)

**OR**

14. Discuss the triggering factors for landslides. Illustrate how they could become disastrous in the case of an infrastructure project. (14)

15. Evaluate the factors giving rise to forest fires. Analyse the influence of climate change on them. (14)

**OR**

16. How does desertification occur? Discuss the mitigation measures. (14)

17. Compare and contrast the concepts of disaster response and recovery with suitable examples. (14)

**OR**

18. Appraise (with suitable examples) the significance of ideas of relief, rehabilitation, reconstruction and recovery in disaster management. (14)

19. Prepare a disaster management plan for a landslide scenario in a hilly terrain. Discuss the organisational set up needed for the same. (14)

**OR**

20. Discuss the various factor to be considered in conducting environmental impact assessment of a highway project, keeping in mind the probable hazards/disasters. (14)

**Course Contents and Lecture Schedule**

| No. | Topic | Course Outcome | No. of Hrs |
|---|---|---|---|
| 1 | **Module 1** | | Total: 3 |
| 1.1 | Introduction, Hazard, disaster, their characteristics and effects, interaction between subsystems of earth that bring about hazards and their intensification. Classification, how development is connected to disasters. Disaster cycle | CO1, CO2 | 2 |
| 1.2 | Hazard and disaster Terminology: vulnerability and types, exposure, risk, capacity, crisis, emergencies, resilience etc. basic concepts of carbon footprint | CO1, CO4 | 1 |
| 2 | **Module 2** | | Total: 8 |
| 2.1 | Natural Disasters: General classification, Causes, types, impact of: Earth quakes, volcanoes, floods, storm surges, tsunamis | CO1, CO2, CO3 | 3 |
| 2.2 | Assessment and mitigation of: Floods, types Coastal disasters: Earth quakes, volcanoes, floods, storm surges, tsunamis. | CO1, CO2, CO3 | 5 |
| 3 | **Module 3** | | Total: 7 |
| 3.1 | Soil, formation, significance and characteristics. Soil degradation, engineering and agricultural methods of prevention | CO1, CO3, CO4 | 2 |
| 3.2 | Desertification: nature and mechanisms, mitigation | CO2, CO3, CO4 | 1 |
| 3.3 | Landslides: processes, controlling factors, classification and impact and alleviation | CO2, CO3, CO4 | 2 |
| 3.4 | Forest fires: incidence and means and deterrence | CO1, CO3, CO4 | 2 |
| 4 | **Module 4** | | Total: 8 |
| 4.1 | Steps in Risk Management and Assessment, Disaster management cycle-Prevention, Preparedness, Response, and Recovery | CO1, CO3, CO4 | 3 |
| 4.2 | SWOT Analysis- concepts, uses, limitations and advantages | CO2, CO3, CO4 | 3 |
| 4.3 | Disaster management plan and reports, participation of community in disaster management | CO3, CO4, CO5 | 2 |
| 5 | **Module 5** | | Total: 9 |
| 5.1 | Hazard and Disaster Management: relief camps, organisation and amenities. Behavioral aspects of management- psychological considerations, training in human professionalism, individual and community empowerment | CO1, CO2, CO4 | 2 |

| | | | |
|---|---|---|---|
| 5.2 | Management of floods, storm surges, landslides, earthquakes, forest fires: pre-disaster phase, actual disaster phase, post-disaster phase. Relief and Amenities, Relief camps, organization, camp layout, food requirement, water needs, sanitation, security. | CO3, CO4, CO5 | 5 |
| 5.3 | Concepts of EIA and sustainable development. | CO5 | 2 |

| CET455 | ENVIRONMENTAL HEALTH AND SAFETY | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | OEC | 2 | 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** | Explain 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. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | 2 | 2 | | | | | |
| **CO2** | 3 | | | | | 2 | 1 | | | | | |
| **CO3** | 3 | | | | | 2 | 2 | | | | | |
| **CO4** | 3 | | | | | 3 | 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 | : | 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 Level Assessment Questions**

| 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 (iv) Anthrax. | 14 | CO1 |
| **Module II** | | | |
| 13(a) | Write briefly about the classification of bio hazardous 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 |

## Syllabus

### 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, McGrawHill Company,NewYork,1980.
3. S.P.Mahajan, “Pollution control in process industries”, Tata McGraw Hill Publishing Company, New Delhi, 1993.

**Course content and Schedule of Lecture**

| Module | Topic | Course outcome addressed | No of Hours |
|---|---|---|---|
| **Module I (7 Hours)** | | | |
| 1.1 | Introduction to Occupational Health And Toxicology. | CO1 | 1 |
| 1.2 | Safety at work – Socio – Economic reasons. | CO1 | |
| 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 | |
| **Module II (7 Hours)** | | | |
| 2.1 | Chemical hazards. | CO2 | 1 |
| 2.2 | Dust, fumes, vapour, fog, gases. | CO2 | |
| 2.3 | Methods of Control. | CO2 | 1 |
| 2.4 | Biological hazards. | CO2 | 1 |
| 2.5 | Classification of Biohazardous agents. | CO2 | |
| 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 (7 Hours)** | | | |
| 3.1 | Safety in Construction industry- Scaffolding and Working platform. | CO3 | 1 |
| 3.2 | Welding and Cutting, Excavation Work, Concreting. | CO3 | |
| 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 (7 Hours)** | | | |
| 4.1 | Air Pollution - air pollutants from industries. | CO4 | 1 |
| 4.2 | Effect on human health, animals. | CO4 | |
| 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 | |
| **Module V (7 Hours)** | | | |
| 5.1 | Safe working environment. | CO5 | 1 |
| 5.2 | The basic purpose and benefits of safety inspection. | CO5 | |
| 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 |

**Model Question Paper**

**Reg. No.:……..** **QP CODE:……..**

**Name:……**

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
**SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR**
**COURSE CODE: CET 455**
**ENVIRONMENTAL 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 bio hazardous agents. (7 Marks)

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

OR

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

**Module III**

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

OR

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

**Module IV**

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

OR

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

**Module V**

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

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

OR

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

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

| CET465 | GEOINFORMATICS | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | OEC | 2 | 1 | 0 | 3 | 2019 |

**Preamble:** This course introduces students to the basics of geographical information system. They will learn basic concepts in geospatial data handling and analysis. They will learn various steps involved in developing a geographical information system. Course will also explore different use cases of GIS applications.

**Prerequisite:** NIL

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

| Course Outcome | Description of Course Outcome | Prescribed learning level |
|---|---|---|
| CO1 | Explain basic concepts of GIS and spatial data | Understand |
| CO2 | Explain various datatypes and database management | Understand |
| CO3 | Choose various spatial data collection technologies & analysis techniques | Apply |
| CO4 | Demonstrate the use of GIS in various applications | Apply |

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

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

**Assessment Pattern**

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

**Mark distribution**

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

**Continuous Internal Evaluation Pattern:**

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

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

**Course Level Assessment Questions**

**CO1: Explain basic concepts of GIS and spatial data**

1.What are the basic components of GIS?

2. How datum and projection are important in representing spatial data?

3. What is georeferencing?

4.What are various map elements?

**CO2: Explain various datatypes and database management**

1. Explain the difference between spatial and attribute data used in GIS.

2. How relational database management systems (RDBMS) are useful?

3. What are the various data models used in GIS?

**CO3: Choose various spatial data collection technologies & analysis techniques**

1. Layers (or levels) are a fundamental means of organizing geographic data in almost all GIS, why?

2. Explain in detail various spatial data analysis techniques used in GIS.

3. Explain how DEMs are built. What are their applications?

4. What is the use of DGPS?

**CO4: Demonstrate on the use of GIS in various applications**

1. Discuss with examples how GIS can be useful in disaster management.

2. GIS is a useful tool in environmental science. Discuss?

3. How geospatial information helps in forest management?

## Syllabus

**Module 1**

Introduction to GIS, History and development of GIS, Spatial data concepts, Coordinate reference systems, datum and projections, map scales, georeferencing, components of GIS, data sources in GIS, data input methods, file formats for GIS, standard GIS packages

**Module 2**

Type of data, Spatial and attribute data, Data models- vector and raster, Spatial data structure- Vector data structure and raster data structure, Database management systems (DBMS), Relational database management systems (RDBMS)

**Module 3**

Spatial data analysis, single layer operations- spatial and attribute query, buffer analysis, point pattern analysis, network analysis, surface analysis, interpolation; multi-layer operations- topological overlays, point in polygon, line in polygon, polygon in polygon, logical operators-

AND, OR, NOT, XOR, vector overlay operations-Clip, erase, split, union, identity and intersect; raster calculators; GIS Modeling

**Module 4**

Digital elevation model (DEM), digital terrain model (DTM), triangular irregular network (TIN) Global navigation satellite systems- types, Global positioning system- components and principle, satellite ranging- calculating position, GPS errors and biases, Differential GPS (DGPS)

**Module 5**

Application of GIS in various fields- Urban planning, agriculture, disaster management, forest management, site suitability analysis for infra projects, environmental science, sales and marketing.

A mini project on application of GIS.

**Text Books:**

1. Anji Reddy, M. Remote Sensing and Geographical Information System, BSP Publications., 2001.
2. Chang, K (2005). Introduction to Geographic Information Systems, Tata McGraw Hills Edition, New Delhi.

**References:**

1. Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992.
2. Burrough P.A., Principles of GIS for Land Resources Assessment, Oxford Publication, 1980.
3. Jeffrey Star and John Estes, Geographical Information System – An Introduction, Prentice – Hall Inc., 1990.
4. Marble D.F., Galkhs H.W. and Pequest, Basic Readings in Geographic Information System, Sped System Ltd., New York, 1984.
5. Clarke, K.C. Parks B.O., and Crane M.P. (2006) Geographic Information systems and environmental modeling- PHI of India, New Delhi.

**Course Contents and Lecture Schedule**

| Module | Topic | Course Outcomes addressed | No. of Lectures |
|---|---|---|---|
| **1** | **Module 1: Total Lecture Hours -7** | | |
| 1.1 | Introduction to GIS, History and development of GIS, Spatial data concepts | CO1 | 2 |
| 1.2 | Coordinate reference systems, datum and projections, map scales, georeferencing | CO1 | 2 |
| 1.3 | Components of GIS, data sources in GIS | CO1 | 1 |
| 1.4 | Data input methods, file formats for GIS, standard GIS packages | CO1 | 2 |
| **2** | **Module II: Total Lecture Hours- 7** | | |
| 2.1 | Type of data, Spatial and attribute data | CO2 | 1 |
| 2.2 | Data models- vector and raster, Spatial data structure- Vector data structure and raster data structure | CO2 | 3 |
| 2.3 | Database management systems (DBMS), Relational database management systems (RDBMS) | CO2 | 3 |
| **3** | **Module III: Total Lecture Hours-7** | | |
| 3.1 | Spatial data analysis, single layer operations-spatial and attribute query, buffer analysis, point pattern analysis, network analysis, surface analysis, interpolation | CO3 | 3 |
| 3.2 | multi-layer operations-topological overlays, point in polygon, line in polygon, polygon in polygon, logical operators-AND, OR, NOT, XOR | CO2 | 2 |
| 3.3 | Vector overlay operations-Clip, erase, split, union, identity and intersect; raster calculators; GIS Modeling | CO2 | 2 |
| **4** | **Module IV: Total Lecture Hours- 7** | | |
| 4.1 | Digital elevation model (DEM), digital terrain model (DTM), triangular irregular network (TIN) | CO3 | 2 |
| 4.2 | Global navigation satellite systems- types, Global positioning system- components and | CO3 | 2 |

| | | | |
|---|---|---|---|
| | principle | | |
| 4.3 | Satellite ranging- calculating position, GPS errors and biases | CO3 | 2 |
| 4.4 | Differential GPS (DGPS) | CO3 | 1 |
| **5** | **Module V: Total Lecture Hours- 7** | | |
| 5.1 | Application of GIS in various fields- Urban planning, agriculture, disaster management | CO4 | 3 |
| 5.2 | GIS application in forest management, site suitability analysis for infra projects | CO4 | 2 |
| 5.3 | GIS application in environmental science, sales and marketing | CO4 | 2 |

**Model Question Paper**

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

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

**Course Code: CET 465**
**Course Name: GEOINFORMATICS**

Max. Marks: 100 Duration: 3 Hours

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

1. Explain georeferencing.
2. What is datum?
3. What is attribute data?
4. Raster is faster but vector is corrector. Discuss
5. What is the application of buffer analysis?
6. What is the use of line in polygon overlay?
7. What is TIN?
8. What are the components of a global positioning system?
9. List the data layers needed for identifying a landslide hazard zone?
10. Water quality analysis was carried out on the samples collected from various public wells within a Panchayat. How will you create a water quality map of the Panchayat?

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

11. (a) Why is it useful to view GIS as a process rather than merely software of hardware? (8 Marks)
    (b) What are the data input methods in GIS? (6 Marks)

OR

12. (a) Explain components of GIS (8 Marks)
    (b) Discuss evolution of GIS. (6 Marks)

13. (a) Explain the difference between attribute and spatial data, give examples (6 Marks)
    (d) How relational database management systems (RDBMS) are useful? (8 Marks)

OR

14. (a) Compare vector and raster data models. (8 Marks)
    (b) What is a vector data structure? (6 Marks)

15. (a) Explain modelling in GIS with examples. (9 Marks)
    (b) What is a raster calculator? (5Marks)

OR

16. (a) Explain network analysis. How it is useful explain with example. (7 Marks)
    (b) Discuss vector overlay operations. (7 Marks)

17. (a) What is DEM? How is it developed? What are its applications? (9 Marks)
    (b) Explain the principle of Global positioning. (5 marks)

OR

18. (a)Discuss the possible errors in global positioning and their causes. (7 Marks)
    (b) Explain the principle of DGPS. What is its application? (7 Marks)

19. (a) Write a note on importance of geospatial technology in natural hazard management. (7 Marks)
    (b) What are the applications of GIS in environmental studies. (7 Marks)

OR

20. (a) Explain the process to develop a GIS for suitability analysis of a reservoir site. (7 Marks)
    (b) How sales and marketing is benefitted by GIS? Explain with example. (7 Marks)

| MCN401 | INDUSTRIAL SAFETY ENGINERING | Category | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | OEC | 2 | 1 | 0 | 3 |

**Preamble**: The course is intended to give knowledge of various safety management principles, various safety systems, various machine guarding devices, hazard identification techniques, energy sources, systems & applications and the need in the present context. Learners will be able to compare different hazard identification tools and choose the most appropriate based on the nature of industry. It aims to equip students in working with projects and to take up research work in connected areas

**Prerequisite**: Nil

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

| | |
|---|---|
| **CO1** | Describe the theories of accident causation and preventive measures of industrial accidents. (Cognitive Knowledge level: **Understand**) |
| **CO2** | Explain about personal protective equipment, its selection, safety performance & indicators and importance of housekeeping. (Cognitive Knowledge level: **Understand**) |
| **CO3** | Explain different issues in construction industries. (Cognitive Knowledge level: **Understand**) |
| **CO4** | Describe various hazards associated with different machines and mechanical material handling. (Cognitive Knowledge level: **Understand**) |
| **CO5** | Utilise different hazard identification tools in different industries with the knowledge of different types of chemical hazards. (Cognitive Knowledge level: **Apply**) |

**Mapping of course outcomes with program outcomes**

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

| **Abstract POs defined by National Board of Accreditation** | | | |
|---|---|---|---|
| **PO1** | Engineering Knowledge | **PO7** | Environment and Sustainability |
| **PO2** | Problem Analysis | **PO8** | Ethics |
| **PO3** | Design/Development of solutions | **PO9** | Individual and team work |
| **PO4** | Conduct investigations of complex problems | **PO10** | Communication |
| **PO5** | Modern tool usage | **PO11** | Project Management and Finance |
| **PO6** | The Engineer and Society | **PO12** | Life long learning |

**Assessment Pattern**

| | Continuous Assessment Tests | | End Semester Examination |
|---|---|---|---|
| | 1 | 2 | |
| Remember | 10 | 10 | 10 |
| Understand | 20 | 20 | 20 |
| Apply | 20 | 20 | 70 |
| Analyse | | | |
| Evaluate | | | |
| Create | | | |

**Mark distribution:**

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

**Continuous Internal Evaluation Pattern:**

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

**Internal Examination Pattern:**

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

**End Semester Examination Pattern:**

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

**Syllabus**

**MCN401- Industrial Safety Engineering (35 hrs)**

**Module I (safety introduction- 5 hrs)**

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.

**Module II (Personal protection in work environment- 7 hrs)**

Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

**Module III (safety issues in construction- 7 hrs)**

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.

**Module IV (safety hazards in machines- 8 hrs)**

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas

welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.

**Module V (hazard identification and analysis- 8 hrs)**

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets (MSDS).

**Text Books:**


1. R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.
2. Paul S V (2000), Safety management System and Documentation training Programme handbook, CBS Publication.
3. Krishnan, N.V. (1997). *Safety management in Industry*. Jaico Publishing House, New Delhi.
4. John V. Grimaldi and Rollin H.Simonds. (1989) *Safety management*. All India Traveller Book Seller, Delhi.
5. Ronald P. Blake. (1973). *Industrial safety.* Prentice Hall, New Delhi.
6. Alan Waring. (1996). *Safety management system*. Chapman & Hall, England.
7. Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai.

8. AIChE/CCPS. (1992). *Guidelines for Hazard Evaluation Proce*dures. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York.

**Course Level Assessment Questions:**

**Course Outcome 1 (CO1):**

1. Which are the various accident causation theories? Explain.
2. Define terms: Accident, Reportable accident, Dangerous occurrence.

**Course Outcome 2 (CO2):**

1. Discuss different types of personal protective equipment
2. Discuss about how to compare the safety performance of two industries.
3. Discuss the significance of work permit system in accident prevention.

**Course Outcome 3 (CO3):**

1. Distinguish ladders and scaffolds along with their safety features**.**
2. Discuss the safety requirement for a confined space entry.
3. Explain the important provision in the National Building Code.

**Course Outcome 4 (CO4):**

1. Explain the various principles used in machine guarding.
2. Explain the issues in mechanical material handling.

**Course Outcome 5 (CO5):**

1. Selection of different types of fire extinguishers accordance to type of fire.
2. Conduct a HAZOP study for a batch rector of your choice.
3. Determine different types of Chemical hazards associated with industries

**MODEL QUESTION PAPER**

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

**VII SEMESTER B. TECH DEGREE EXAMINATION**

**MCN401- INDUSTRIAL SAFETY ENGINEERING**

**Maximum: 100 Marks** **Duration: 3 hours**

**PART A**

Answer all questions, each question carries 3 marks

1. Differentiate Unsafe act and Unsafe conditions with suitable examples
2. Discuss the significance of a safety committee in improving the safety performance of an industry
3. Which are the different types of permit? Highlight its suitability.
4. Which are five 'S' used in housekeeping?
5. List the various safety features of ladders.
6. How safety of the workers can be ensured during a demolition operations.
7. Which are the hazards associated with manual material handling?
8. Discuss the safety issues of Gas welding operations.
9. Differentiate Hazard and Risk.
10. Why MSDS is mandatory for chemical products.

(10 X 3 = 30 Marks)

**PART B**

Answer one full question from each module

**Module 1**

11. List the various accident causation theories and explain any one in details. (14 Marks)
12. a) Discuss the significance of safety policy in reducing the accidents. (4 Marks)

    b) Safety and productivity are the two sides of a coin'. Are you agreeing with this statement? Explain with your arguments. (10 Marks)

**Module 2**

13. a) Classify the personal protective equipment. List the suitability of at least fifteen types of PPEs. (10 Marks)

b) How will you calculate the frequency rate? Explain with an example. (4 Marks)

14. a) How will you compare the safety performance of two industries? Explain with suitable example. (10 Marks)

    b) Which are the steps to be followed in confined space entry to protect the life a worker. (4 Marks)

**Module 3**

15. Discuss the safety and fire protection facilities required for a high rise building as per National building code. (14 Marks)

16. a) Identify the various hazards during the different stages of building construction. (7 Marks)

    b) Discuss the important types of ergonomic hazards associated with industries.(7 Marks)

**Module 4**

17. Which are the various types of machine guarding devices used industries. Discuss the suitability of each machine guarding devices. (14 Marks)

18. With suitable sketches briefly explain seven defects of wire ropes. (14 Marks)

**Module 5**

19. What is Hazard and Operability Analysis? How do you conduct a HAZOP analysis? (14 Marks)

20. Discuss about different types of chemical hazards. (14 Marks)

## Course Contents and Lecture Schedule

| No. | Topic | No. of Lectures/ Tutorials L-T |
|---|---|---|
| 1 | **Introduction to Industrial safety Engineering** | |
| 1.1 | Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence. Reportable accidents | 1 |
| 1.2 | Theories of accident causation. Safety organization. | 2 |
| 1.3 | Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. | 3 |
| 1.4 | Safety Officer-responsibilities, authority. | 4 |
| 1.5 | Safety committee-need, types, advantages. | 5 |
| 2 | **Personal protection in the work environment** | |
| 2.1 | Types of PPEs, respiratory and non-respiratory equipment. | 6 |
| 2.2 | Standards related to PPEs | 7 |
| 2.3 | Monitoring Safety Performance: Frequency rate, severity rate | 8, |
| 2.4 | Monitoring Safety Performance: incidence rate, activity rate. | 9 |
| 2.5 | Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. | 10 |
| 2.6 | Work permit system- objectives, hot work and cold work permits. | 11 |
| 2.7 | Typical industrial models and methodology. Entry into confined spaces. | 12 |
| 3 | **Introduction to construction industry and safety** | |
| 3.1 | Excavation and filling – Under-water works – Under-pinning & Shoring | 13 |
| 3.2 | Ladders & Scaffolds – Tunneling | 14 |
| 3.3 | Blasting –Demolition – Confined space | 15 |
| 3.4 | Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. | 16 |
| 3.5 | Relevance of ergonomics in construction safety. | 17 |
| 3.6 | Ergonomics Hazards | 18 |
| 3.7 | Musculoskeletal Disorders and Cumulative Trauma Disorders. | 19 |
| 4 | **Machinery safeguard** | |

| CEL411 | ENVIRONMENTAL ENGG LAB | CATEGORY | L | T | P | CREDIT | YEAR OF INTRODUCTION |
|---|---|---|---|---|---|---|---|
| | | PCC | 0 | 0 | 3 | 2 | 2019 |

**Preamble:** This lab provides the knowledge on tests used to analyse the physio-chemical and bacteriological properties of water and explains the various method followed in the test along with its suitability as a drinking water.

**Prerequisite**: CET 304 Environmental Engineering

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

| Course outcome | Description |
|---|---|
| CO1 | Analyse various physico-chemical and biological parameters of water |
| CO2 | Compare the quality of water with drinking water standards and recommend its suitability for drinking purposes |

**Mapping of course outcomes with program outcomes:**

| | PO 1 | PO2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO9 | PO1 0 | PO1 1 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 1 | - | 3 | 3 | - | - | - | - | 3 |
| CO2 | 3 | 3 | 3 | 1 | - | 3 | 3 | - | - | - | - | 3 |

**Assessment Pattern:**

**Mark distribution**

| Total marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 150 | 75 | 75 | 3 Hrs |

**Continuous Internal Evaluation (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 mark

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

**Instructions:**

- Any 12 of the 18 experiments included in the list of experiments need to be performed mandatorily.
- Virtual Lab facility cannot be used to substitute the conduct of these mandatory experiments.
- Periodic maintenance and calibration of various testing instruments needs to be made.
- Practical examination to be conducted covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

**Syllabus**

1. Determination of pH, Electrical Conductivity and Turbidity*
2. Determination of TS, TDS and TSS, TVS *
3. Determination of Alkalinity and Acidity *
4. Determination of Hardness *
5. Determination of Chlorides
6. Determination of Total Iron
7. Determination of Biochemical Oxygen Demand*
8. Determination of Chemical Oxygen Demand*
9. Optimum Coagulant dosage*
10. Break point Chlorination *
11. Determination of Available Chlorine in a sample of bleaching powder
12. Determination of Sulphates
13. Determination of Fluoride
14. Determination of Dissolved Oxygen*
15. Determination of nitrates
16. Determination of phosphates
17. Determination of any two Heavy Metal concentration

18. Total coliforms *

Note: * mandatory

**References**


1. Standard Methods for the Examination of Water and Wastewater, 23rd edition, American Public Health Association, American Water Works Association, Water Environment Federation, 2017.
2. Water Supply Engineering, 33rd edition, Santhosh Kumar Garg, Khanna publishers.
3. Sewage Disposal and Air Pollution Engineering, 39th edition, Santhosh Kumar Garg, Khanna publishers.
4. IS: 10500:2012 Drinking Water - Specification, Second revision, Bureau of Indian Standards, 2012.

| CEQ413 | SEMINAR | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | PWS | 0 | 0 | 3 | 2 |

**Preamble:** The course 'Seminar' is intended to enable a B.Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

**Course Objectives:**

- To do literature survey in a selected area ofstudy.
- To understand an academic document from the literate and to give a presentation about it.
- To prepare a technical report.

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

| | |
|---|---|
| CO1 | Identify academic documents from the literature which are related to her/his areas of interest (Cognitive knowledge level: **Apply**). |
| CO2 | Read and apprehend an academic document from the literature which is related to her/ his areas of interest (Cognitive knowledge level: **Analyze**). |
| CO3 | Prepare a presentation about an academic document (Cognitive knowledge level: **Create**). |
| CO4 | Give a presentation about an academic document (Cognitive knowledge level: **Apply**). |
| CO5 | Prepare a technical report (Cognitive knowledge level: **Create**). |

**Mapping of course outcomes with program outcomes:**

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

| Abstract POs defined by National Board of Accreditation | | | |
|---|---|---|---|
| **PO#** | **Broad PO** | **PO#** | **Broad PO** |
| PO1 | Engineering Knowledge | PO7 | Environment and Sustainability |
| PO2 | Problem Analysis | PO8 | Ethics |
| PO3 | Design/Development of solutions | PO9 | Individual and team work |
| PO4 | Conduct investigations of complex problems | PO10 | Communication |
| PO5 | Modern tool usage | PO11 | Project Management and Finance |
| PO6 | The Engineer and Society | PO12 | Life long learning |

**General Guidelines**

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

## Evaluation pattern

**Total marks: 100, only CIE, minimum required to pass 50**

**Seminar Guide:** 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

**Seminar Coordinator:** 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

**Presentation:** 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

**Report:** 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

| CED415 | PROJECT PHASE I | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | PWS | 0 | 0 | 6 | 2 |

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

**Course Objectives**

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

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

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

**Mapping of course outcomes with program outcomes**

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

| Abstract POs defined by National Board of Accreditation | | | |
|---|---|---|---|
| **PO#** | **Broad PO** | **PO#** | **Broad PO** |
| PO1 | Engineering Knowledge | PO7 | Environment and Sustainability |
| PO2 | Problem Analysis | PO8 | Ethics |
| PO3 | Design/Development of solutions | PO9 | Individual and team work |
| PO4 | Conduct investigations of complex problems | PO10 | Communication |
| PO5 | Modern tool usage | PO11 | Project Management and Finance |
| PO6 | The Engineer and Society | PO12 | Lifelong learning |

## PROJECT PHASE I

**Phase 1 Target**

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

**Evaluation Guidelines & Rubrics**

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20 Marks.

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

## Evaluation by the Guide

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

**Topic Selection:** innovativeness, social relevance etc. (2)

**Problem definition:** Identification of the social, environmental and ethical issues of the project problem. (2)

**Purpose and need of the project:** Detailed and extensive explanation of the purpose and need of the project. (3)

**Project Objectives:** All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

**Project Scheduling & Distribution of Work among Team members:** Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

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

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

**Individual Contribution:** The contribution of each student at various stages. (7)

| EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation | | | | | | |
|---|---|---|---|---|---|---|
| **No.** | **Parameters** | **Marks** | **Poor** | **Fair** | **Very Good** | **Outstanding** |
| 1-a | Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment)<br><br>[CO1] | 10 | The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet. | The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough. | Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough. | The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible. |
| | | | (0 – 3 Marks) | (4 – 6 Marks) | (7 - 9 Marks) | (10 Marks) |
| 1-b | Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment)<br><br>[CO4] | 10 | No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept. | Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members. | Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete.<br>Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement. | Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks. |
| | | | (0 – 3 Marks) | (4 – 6 Marks) | (7 - 9 Marks) | (10 Marks) |
| **Phase 1 Interim Evaluation Total Marks: 20** | | | | | | |

**EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation**

| Sl. No. | Parameters | Marks | Poor | Fair | Very Good | Outstanding |
|---|---|---|---|---|---|---|
| 1-c | Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1] | 5 | None of the team members show any evidence of knowledge about the design and the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation. | The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan. | The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent. | Shows clear evidence of having a well- defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable. |
| | | | (0 – 1 Marks) | (2 – 3 Marks) | (4 Marks) | (5 Marks) |
| 1-d | Individual and Teamwork Leadership ( Individual assessment) [CO3] | 10 | The student does not show any interest in the project activities, and is a passive member. | The student show some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature. | The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well. | The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership. |
| | | | (0 – 3 Marks) | (4 – 6 Marks) | (7 - 9 Marks) | (10 Marks) |
| 1-e | Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study [CO1] | 10 | The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/desig n/feasibility study/ algorithm development. | The team has started doing some preliminary work with respect to the project. The students however are not prepared enough for the work and they need to improve a lot. | There is some evidence to show that the team has done good amount of preliminary investigation and design/ analysis/ modeling etc. They can improve further. | Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and are poised to finish the phase I in an excellent manner. They have shown results to prove their progress. |
| | | | (0 – 3 Marks) | (4 – 6 Marks) | (7 - 9 Marks) | (10 Marks) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1-f | Documentation and presentation. (Individual & group assessment).<br><br>[CO6] | 5 | The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance.<br>The individual student has no idea on the presentation of his/her part. | Some documentation is done, but not extensive. Interaction with the guide is minimal.<br>Presentation include some points of interest, but overall quality needs to be improved. Individual performance to be improved. | Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good. | The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structure is well-planned and can easily grow into the project report.<br><br>The presentation is done professionally and with great clarity. The individual's performance is excellent. |
| | | | (0 – 1 Marks) | (2 – 3 Marks) | (4 Marks) | (5 Marks) |
| **Total** | | **30** | **Phase - I Final Evaluation Marks: 30** | | | |

| EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No.** | **Parameters** | **Marks** | **Poor** | **Fair** | **Very Good** | **Outstanding** |
| 1-g | Report [CO6] | 20 | The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly Unacknowledged content. Lack of effort in preparation is evident. | Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. | Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly. | The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles. |
| | | | (0 - 7 Marks) | (8 - 12 Marks) | (13 - 19 Marks) | (20 Marks) |
| **Phase - I Project Report Marks: 20** | | | | | | |