SEMESTER -4

CET202	Engineering Geology	Category	L	T	P	Credits	Year of Introduction
		PCC	3	0	1	4	2020

Preamble: Goal of this course is to introduce to the students the basics of earth processes, materials, groundwater and the geological characteristics of such processes and materials which are relevant to the Civil Engineering applications.

Prerequisites: Nil

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

CO1	Recall the fundamental concepts of surface processes, subsurface process, minerals, rocks, groundwater and geological factors in civil engineering constructions.
CO2	Identify and describe the surface processes, subsurface process, earth materials, groundwater and geological factors in civil engineering constructions.
CO3	Apply the basic concepts of surface and subsurface processes, minerals, rocks, groundwater and geological characteristics in civil engineering constructions.
CO4	Analyze and classify geological processes, earth materials and groundwater.
CO5	Evaluation of geological factors in civil engineering constructions.

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	9 (3 marks for each question in which one question from third module)	6	15
Understand	6	9 (3 marks for each question in which one question from third module)	15
Apply	14 +14 + 7 (Question for 7 marks is from third module)	14 +14 + 7 (Question for 7 marks is from third module)	70
Analyse			
Evaluate			

Mark distribution

Total Marks	CIE marks	ESE marks	Test 1 &2 Duration	ESE Duration
150	50	100	1.5 hours	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10marks

Continuous Assessment Test (2 numbers): 25 marks

Assignment/Quiz/Courseproject: 15 marks

End Semester ExaminationPattern:

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

Course Level Assessment Questions:

Part A

Course Outcome 1 (CO1): (One question from each module to meet the course objective 1: To recall the fundamental concepts of surface processes, subsurface process, minerals, rocks, groundwater and geological factors in civil engineeringconstructions).

1. Define weathering of rocks

Course Outcome 2 (CO2) (One question from each module to meet the course objective 2: To identify and describe the surface processes, subsurface process, earth materials, groundwater and geological factors in civil engineering constructions.)

1. Explain the classification of soil

Part B

All the questions under this section shall assess the learning levels corresponding to the course outcomes 3, 4 and5.

1. **a)** Classify weathering and discuss the engineering classification of weathered rock masses (7 marks)

   b) Write your comments on the relevance of geology in civil engineering constructions (7 marks)

Model Question Paper

QP CODE:

RegNo.:_____

Name:_____

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

Course Code: CET 202

ENGINEERING GEOLOGY

Max.Marks: 100 Duration: 3hours

Part A

(Answer all questions; each question carries 3 marks)

1. Define weathering ofrocks

2. Explain soil erosion and classification ofsoils

3. Describe earthquakes and write notes on seismograph andseismogram

4. Illustrate the elastic rebound theory with adiagram

5. Define Ghyben Herzberg relation in sea waterintrusion

6. Explain Darcy's Law with a neatdiagram

7. Write down the physical properties and chemical composition of givenminerals

a. Calcite

b. Gypsum

8. Describe the different types of igneous rocks based on theirorigin

9. Illustrate the major parts of the fold with a neatdiagram

10. Distinguish between clinometer compass and Brunton compass

PART B

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

Module -1

11. a) Discuss the relevance of geology in civil engineering constructions (7marks)

b) Give an account on classification of weathering with suitable diagrams and examples (7 marks)

12. Describe the geological work of rivers. Discuss different landform features produced by weathering and river action with suitable diagrams. (14 marks)

Module -2

13. Comment on the relation of earthquakes with plate tectonics. Give an account on different plates with earthquake prone area (14 marks)

14. Discuss the various types of seismic waves and their relevance in the study of internal structure of earth. (14marks)

Module -3

15. Discuss the vertical distribution of groundwater. Give an account of the water bearing properties of rocks and hydrological cycle with neat diagrams. (14marks)

16. a) Elucidate application of electrical resistivity survey in ground water exploration. (8 marks)

b) Give a brief account on different ground water recharge methods (6 marks)

Module -4

17. Distinguish between metamorphic and sedimentary rocks with respect to their structure with diagrams (14marks)

18. a) Elucidate various physical properties of minerals for their identification. (9marks)

b) Give an account on hardness of minerals with Moh's hardness scale (5 marks)

Module -5

19. a) Enumerate the geological factors to be considered for selecting a dam site (9 marks)

b) Discuss the geological conditions suitable and unsuitable for construction of tunnels (5marks)

20. Distinguish between folds and faults. Give an account on classification of folds with neat diagrams (14 marks)

ENGINEERING GEOLOGY

Syllabus

Module	Contents	Hours
Module 1 External Earth Processes	Relevance of Geology in Civil Engineering, **Surface Processes of the earth**- a) Weathering of rocks-Types of weathering, Processes of Origin of Products of weathering like sand, clay, laterite and soil, soil profile, Soil erosion and soil conservation measures. Engineering significance of weathering. b) Geological processes by rivers. c) Landslides-types, causes and controlling measures, Coastal Processes-Geological work by waves and currents and coastal protectionmeasures	9
Module 2 Internal Earth Processes	**Internal Processes of the earth-** a) Earthquakes- Plate Tectonics, Origin of earthquakes, Seismic waves, Rating of earthquakes, types of earthquakes, Seismic zones of India. Basics of seismic safety factor, Interior of the earth as revealed by propagation of seismic waves.	9
Module 3 Groundwater	**Hydrogeology**-Occurrence of groundwater, aquifers and types of aquifers, confining beds, porosity and vertical distribution of groundwater. Darcy's Law.Permeability/hydraulic conductivity. Problems created by groundwater to civil engineering structures, Methods to control groundwater problems, Electrical resistivity survey for groundwater exploration. Seawater intrusion in Coastal area.Ghyben Herzberg relation.	9
Module 4 Earth Materials	**Mineralogy-**Physical properties of minerals, physical properties and chemical composition of minerals like quartz, orthoclase, plagioclase, biotite, muscovite, hornblende, augite, hypersthene, calcite, gypsum. **Petrology-**Igneous, sedimentary and metamorphic rocks, Igneous rocks-Chemical and mineralogical classification and structure. Sedimentary rocks-types based on mode of formation and structures Metamorphic rocks-structures only. Megascopic study of granite, dolerite, basalt, sandstone, limestone, shale, gneiss, marble and charnockite. Rock types of Kerala. Rockcycle	9
Module 5 Secondary Structures of Rocks	**Structural Geology–** Attitude of rocks – Dip and Strike. Terminology, brief classification and engineering significance of folds, faults and joints. Geological part of site investigation for the construction of dams, reservoirs and tunnels. Toposheet.Structuralmapping.Clinometer compass and Brunton compass.	9

Textbooks

1. Duggal S.K, Pandey H.K and Rawat N (2014) Engineering Geology, Mcgraw Hill Education NewDelhi
2. Gokhale KVGK (2015) Principles of Engineering Geology, BS Publications, Hyderabad

3. Singh P (2014) Engineering and General Geology, SK Kataria and sons, NewDelhi
4. SubinoyGangopadhyay (2017) Engineering Geology, OxfordUniversity

References

1. David K Todd & Larry W Mays (2011) Groundwater Hydrogeology, Wiley India Pvt Ltd.
2. Gokhale N.W. (2015) Manual of Geological Maps, CBS Publishers, NewDelhi
3. Gribble CD (2005) Rutleys Elements of Mineralogy,Springer
4. Marland P Billings (2016), Structural Geology, Pearson education

Course Contents and Lecture Schedule:

Module	Topic	No. of hours
Module 1	Weathering of rocks-Types of weathering, Processes of Origin of Products of weathering like sand, clay, laterite and soil	3
	Soil profile, Soil erosion and soil conservation measures. Engineering significance of weathering.	2
	Geological processes by rivers. Landslides-types, causes and controlling measures	2
	Coastal Processes-Geological work by waves and currents and coastal protection measures	2
Module 2	Earthquakes- Plate Tectonics, Origin of earthquakes, Seismic waves, Rating of earthquakes, types of earthquakes	4
	Seismic zones of India. Basics of seismic safety factor	2
	Interior of the earth as revealed by propagation of seismic waves.	3
Module 3	Occurrence of groundwater, aquifers and types of aquifers, confining beds, porosity and vertical distribution of groundwater.	2
	Darcy's Law.Permeability/hydraulic conductivity. Problems created by groundwater to civil engineering structures	3
	Methods to control groundwater problems	1
	Electrical resistivity survey for groundwater exploration.	2
	Seawater intrusion in Coastal area. Ghyben Herzberg relation.	1
Module 4	Physical properties of minerals, physical properties and chemical composition of minerals like quartz, orthoclase, plagioclase, biotite, muscovite, hornblende, augite, hypersthene, calcite, gypsum	4

	Igneous, sedimentary and metamorphic rocks, Igneous rocks-Chemical and mineralogical classification and structure. Sedimentary rocks-types based on mode of formation and structures Metamorphic rocks-structures only. Megascopic study of granite, dolerite, basalt, sandstone, limestone, shale, gneiss, marble and charnockite. Rock types of Kerala. Rock cycle	**5**
Module 5	Attitude of rocks – Dip and Strike. Terminology	**1**
	Brief classification and engineering significance of folds, faults and joints	**3**
	Geological part of site investigation for the construction of dams, reservoirs and tunnels	**3**
	Toposheet, Structural mapping. Clinometer compass and Brunton compass	**2**

CET 204	GEOTECHNICAL ENGINEERING - I	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	4	0	0	4	2019

Preamble: Goal of this course is to expose the students to the fundamental concepts of soil mechanics and laboratory tests to determine the basic, index and engineering properties of soils. After this course, students will be able to identify and classify the soil and to recognize practical problems in real-world situations and respond accordingly.

Prerequisite : Nil

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

CO 1	Explain the fundamental concepts of basic and engineering properties of soil
CO 2	Describe the laboratory testing methods for determining soil parameters
CO 3	Solve the basic properties of soil by applying functional relationships
CO 4	Calculate the engineering properties of soil by applying the laboratory test results and the fundamental concepts of soil mechanics
CO 5	Analyze the soil properties to identify and classify the soil

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	10	10	20
Understand	10	15	20
Apply	25	25	50
Analyse	5		10
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation (CIE) Pattern :

Attendance : 10 Marks

Continuous Assessment Test (2 numbers) : 25 Marks

Assignment/Quiz/Course project : 15 Marks

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

Course Level Assessment Questions

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

Course Outcome 1 (CO1):

1. The fundamental concepts of basic properties and index properties of soil
2. The fundamental concepts of engineering properties of soils related to Permeability, consolidation, compaction & shear strength
3. Concepts of Total, neutral and effective stress; and vertical stress below loaded areas
4. Concepts of Slope stability

Course Outcome 2 (CO2):

1. The laboratory testing methods for determining basic and index soil properties
2. The laboratory testing methods for determining engineering properties related to Permeability, consolidation, compaction & shear strength

Course Outcome 3 (CO3):

1. Solve the basic properties of soil by applying functional relationships

Course Outcome 4 (CO4):

1. Calculate the engineering properties of soil related to Permeability, consolidation, compaction & shear strength by applying the laboratory test results
2. Calculate the settlement of footings due to consolidation and application of time rate of consolidation settlement
3. Calculate the engineering properties of soil by applying the concepts of soil mechanics related to total , neutral and effective stress; and vertical stress below loaded areas
4. Calculate the stability of slopes

Course Outcome 5 (CO5):

1. Identify and classify the soil by analysing the basic and index properties of soil

Model Question Paper

QP CODE:

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

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CET 204

Course Name : GEOTECHNICAL ENGINEERING - I

Max. Marks: 100 Duration: 3 hours

Part A

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

1. Draw a three phase block diagram and define (i) Void Ratio, (ii) Water Content and (iii) Degree of saturation
2. Explain the procedure for Specific Gravity test using Pycnometer.
3. Define (i) Liquid Limit, (ii) Plastic Limit & (iii) Shrinkage Limit
4. Differentiate between Coefficient of Permeability and Coefficient of Percolation.
5. Explain Total Stress, Neutral Stress and Effective Stress.
6. List the assumptions of Boussinesq's theory.
7. Define pre consolidation pressure. Explain the method for the estimation of pre consolidation pressure.
8. Differentiate between Consolidation and Compaction.
9. Explain Mohr Coulomb shear strength theory.
10. What are the different types of slope failures?

PART B

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

Module – 1

11. (a) Derive the relation between bulk unit weight, specific gravity, void ratio and degree of saturation from the fundamentals. (5 Marks)

    (b) A sample of wet silty clay soil weighs 1.26 kN. The following data were found from lab tests on the sample. Density γ = 21 kN/m3, Water content w = 15%, Specific Gravity G = 2.7. Determine (i) Dry density, (ii) Void Ratio, (iii) Porosity (iv) Degree of Saturation, (v) Saturated unit weight (vi) Submerged unit weight and (vii) Volume of soil. (9 Marks)

12. (a) Explain different types of soil structures. (5 Marks)

(b) 1000 cm3 core cutter weighing 9.46 N was used to find out the in-situ unit weight of soil in an embankment. The weight of core cutter with in-situ soil was noted to be 27.7 N. Laboratory tests on the sample indicated water content of 10% and specific gravity of solids of 2.63. Determine the bulk unit weight, dry unit weight, void ratio and degree of saturation. Also calculate the saturated unit weight and the corresponding water content if the embankment is saturated during rain without change in volume. (9 Marks)

Module – 2

13. (a) What is the use of particle size distribution curve? With the help of particle size distribution curve define the following terms (i) well graded soil (ii) poorly graded soil and (iii) gap graded soil. (5 Marks)

(b) Tests on a fined grained soil sample indicated the following properties:

Liquid Limit = 52%, Plastic Limit = 32% and Shrinkage Limit = 17%. Classify the soil as per IS Code. If the specimen of this soil shrinks from a volume of 10 cm^3 at Liquid Limit to 6 cm^3 at the shrinkage limit, calculate the specific gravity of solids. (9 Marks)

14. (a) Explain the factors affecting permeability of soil. (5 Marks)

(b) A soil sample of height 6 cm and area of cross section 100 cm^2 was subjected to constant head permeability test with head of 36 cm and 90 cc of water passes through the specimen during a test interval of 5 min. Compute the coefficient of permeability of the soil sample.
If the same sample is subjected to falling head permeability test and found that head drops from 60 cm to 20 cm in 4 min. Determine the cross sectional area of the stand pipe. (9 Marks)

Module – 3

15. (a) Explain Quick Sand Condition and Critical Hydraulic Gradient. (5 Marks)

(b) A sand deposit of 8 m thick was loaded with a uniform surcharge of 10 kN/m^2. Water table (WT) is at 3 m below GL. Density of sand is 18 kN/m^3 above WT and 19 kN/m^3 below WT. Draw Total, Neutral and Effective Stress Diagrams up to 8 m below GL. Take γ_w = 10 kN/m^3. (9 Marks)

16. (a) A concentrated load of 500 kN is applied at ground surface. Compute the vertical pressure (i) at a depth of 5m below the load, (ii) at a distance of 3m at the same depth. Use Boussinesq's theory. (7 Marks)

(b) A water tank is founded on a circular ring type of foundation. The ring is of 2.5m width and its external diameter is 10m. Compute the vertical stress at 4m depth beneath the centre of the foundation, if pressure on the foundation is 100kPa. (7 Marks)

Module – 4

17. (a) A 8 m thick clay layer with double drainage settles by 120 mm in 2 years. Cv = 1.5 x 10^{-3} cm^2/sec. Calculate the likely ultimate consolidation settlement and find out how long it will take to undergo 90% of this settlement. (5 Marks)

(b) A 3m square footing at a depth of 2m from ground level carries a net load intensity of 150 kN/m^2. If a compressible clay layer 3m thick exists at a depth of 5m below the footing, determine the settlement of the footing due to consolidation of clay layer. Assume the water table at a depth of 3m below GL. For sand, density = 18 kN/m^3 above water table and

19 kN/m^3 below water table. For clay layer, LL = 65%, w_n = 40% and G = 2.7. Take γ_w = 10 kN/m^3. (9 Marks)

18. (a) Explain the field compaction methods. (5 Marks)

(b) The following are results of a standards proctor compaction test performed on a sample of soil

Water Content %	6	8	10	12	14	16
Bulk Density (kN/m^3)	17.7	19.8	21	21.3	20.9	20.2

Plot the water content – dry density curve and obtain Moisture content and Maximum dry density. Also plot the zero air voids curve. Take G = 2.65. (9 Marks)

Module – 5

19. (a) A cylindrical specimen of soil fails under axial vertical stress of 150 kN/m^2, when it is laterally unconfined. Failure plane makes an angle of 53° with the horizontal. Determine shear strength parameters c & ϕ. (5 Marks)

(b) Determine the shear strength parameters using the following data using graphical method:

Sample	Confining Pressure σ_c (kN/m^2)	Deviator Stress σ_d (kN/m^2)
1	100	600
2	200	750
3	300	900

(9 Marks)

20. (a) Explain the Swedish circle method for the analysis of slopes for a c-ϕ soil. (5 Marks)

(b) Determine factor of safety of vertical foundation trench 5m deep if c = 50 kN/m^2, ϕ = 25°, γ = 17 kN/m^3. Assume Taylor's stability no. Sn = 0.166. (9 Marks)

SYLLABUS

Module 1

Nature of soil and functional relationships : Introduction to soil mechanics – Soil types – Major soil deposits of India - 3 phase system – Basic soil properties : Void ratio, porosity, degree of saturation, air content, water content, specific gravity, unit weight - Relationship between basic soil properties - Numerical problems

Determination of Water content by oven drying, Specific gravity using pycnometer & specific gravity bottle - Determination of Field density by sand replacement method & Core Cutter method - Numerical problems

Soil Structure and their effects on the basic soil properties – Sensitivity and Thixotropy

Module 2

Index properties : Sieve analysis – Well graded, poorly graded and gap graded soils - Stoke's law – Hydrometer analysis [no derivation required for percentage finer and diameter] – Relative Density - Numerical problems - Consistency – Atterberg Limits and indices – Plasticity charts - laboratory tests for Liquid Limit, Plastic Limit & Shrinkage Limit - Numerical problems

IS classification of soil - Numerical problems

Permeability of soils : Darcy's law – Factors affecting permeability – Laboratory tests: Constant head and falling head permeability tests - Numerical problems - Average permeability of stratified deposits - numerical problems

Module 3

Principle of effective stress - Total, neutral and effective stress – Pressure diagrams - Numerical problems - Pressure diagrams in soils saturated by capillary action – Quick sand condition – Critical hydraulic gradient

Stress distribution : Introduction - Boussinesq's equations for vertical pressure due to point loads and line loads – Assumptions and Limitations - Numerical problems - Vertical pressure due to uniformly distributed loads beneath strip, circular and rectangular shapes [no derivation required] - Numerical problems

Approximate methods for vertical stress-distribution of contact pressure beneath footings : Equivalent Point Load method & 2:1 Distribution Method - Numerical problems - Pressure Isobars - Pressure bulbs – Newmark's charts (Construction procedure not required) and their use.

Module 4

Consolidation - Definition – Concepts of Coefficient of compressibility and volume compressibility - e-log p curve - Compression index, Recompression index and Pre consolidation Pressure - Normally consolidated, over consolidated and under consolidated soils - Estimation of magnitude of settlement of normally consolidated clays - Numerical problems

Terzaghi's theory of one-dimensional consolidation (no derivation required) - average degree of consolidation – Time factor - Coefficient of consolidation - Numerical problems - Laboratory consolidation test – Determination of Coefficient of Consolidation - Practical Applications

Compaction of soils - Difference between consolidation and compaction - IS Light & Heavy Compaction Tests – OMC and MDD - Zero Air voids line - Numerical problems - Control of

compaction - Field compaction methods - Proctor needle for field control

Module 5

Shear strength of soils- Practical Applications - Mohr-Coulomb failure criterion - Mohr circle method for determination of principal planes and stresses– relationship between shear parameters and principal stresses - Numerical problems

Brief discussion of Laboratory tests - Triaxial compression test - UU, CU and CD tests - Total and effective stress strength parameters - Unconfined compression test, Direct shear test and vane shear test – Applicability - Numerical problems

Stability of finite slopes - Toe failure, base failure, slip failure - Swedish Circle Method : ϕ=0 analysis and c-ϕ analysis - Friction circle method - Taylor's Stability number - Stability charts - Numerical Problems

Text Books:

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

References:

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

Course Contents and Lecture Schedule:

Module	Contents	Outcomes Addressed	Hours
1	**Module 1**		**9**
1.1	**Nature of soil and functional relationships** : Introduction to soil mechanics – Soil types – Major soil deposits of India	CO 1	1
1.2	3 phase system – Basic soil properties : Void ratio, porosity, degree of saturation, air content, water content, specific gravity, unit weight	CO 1	1
1.3	Relationship between basic soil properties	CO 1 & CO 3	1
1.4	Numerical problems	CO 3	2
1.5	Determination of Water content by oven drying, Specific gravity using pycnometer & specific gravity bottle	CO 2	1
1.6	Determination of Field density by sand replacement method & Core Cutter method	CO 2	1
1.7	Numerical problems	CO 3 & CO 4	1
1.8	Soil Structure and their effects on the basic soil properties – Sensitivity and Thixotropy	CO 1 & CO 5	1
2	**Module 2**		**9**
2.1	**Index properties** : Sieve analysis – Well graded, poorly graded and gap graded soils	CO 1 & CO 2	1
2.2	Stoke's law – Hydrometer analysis [no derivation required for percentage finer and diameter] – Relative Density	CO 1 & CO 2	1
2.3	Numerical problems	CO 4	1
2.4	Consistency – Atterberg Limits and indices – Plasticity charts - laboratory tests for Liquid Limit, Plastic Limit & Shrinkage Limit	CO 1 & CO 2	1
2.5	Numerical problems	CO 4	1
2.6	IS classification of soil - Numerical problems	CO 1 & CO 5	1
2.7	**Permeability of soils** : Darcy's law – Factors affecting permeability – Laboratory tests: Constant head and falling head permeability tests	CO 1 & CO 4	1
2.8	Numerical problems	CO 4	1
2.9	Average permeability of stratified deposits - numerical problems	CO 1 & CO 4	1
3	**Module 3**		**9**
3.1	**Principle of effective stress** - Total, neutral and effective stress – Pressure diagrams	CO 1	1
3.2	Numerical problems	CO 4	1
3.3	Pressure diagrams in soils saturated by capillary action – Quick sand condition – Critical hydraulic gradient	CO 1	1
3.4	**Stress distribution** : Introduction - Boussinesq's equations for vertical pressure due to point loads and line loads – Assumptions and Limitations	CO 1	1

3.5	Numerical problems	CO 4	1
3.6	Vertical pressure due to uniformly distributed loads beneath strip, circular and rectangular shapes [no derivation required]	CO 1	1
3.7	Numerical problems	CO 4	1
3.8	Approximate methods for vertical stress-distribution of contact pressure beneath footings : Equivalent Point Load method & 2:1 Distribution Method - Numerical problems	CO 1 & CO 4	1
3.9	Pressure Isobars - Pressure bulbs – Newmark's charts (Construction procedure not required) and their use.	CO 1	1
4	**Module 4**		**9**
4.1	**Consolidation** - Definition – Concepts of Coefficient of compressibility and volume compressibility - e-log p curve - Compression index, Recompression index and Pre consolidation Pressure	CO 1	1
4.2	Normally consolidated, over consolidated and under consolidated soils - Estimation of magnitude of settlement of normally consolidated clays	CO 1 & CO 4	1
4.3	Numerical problems	CO 4	1
4.4	Terzaghi's theory of one-dimensional consolidation (no derivation required) - average degree of consolidation – Time factor - Coefficient of consolidation	CO 1 & CO 4	1
4.5	Numerical problems	CO 4	1
4.6	Laboratory consolidation test – Determination of Coefficient of Consolidation - Practical Applications	CO 2 & CO 4	1
4.7	**Compaction of soils** - Difference between consolidation and compaction - IS Light & Heavy Compaction Tests – OMC and MDD - Zero Air voids line	CO 1, CO2 & CO 4	1
4.8	Numerical problems	CO 4	1
4.9	Control of compaction - Field compaction methods - Proctor needle for field control	CO 1	1
5	**Module 5**		**9**
5.1	**Shear strength of soils**- Practical Applications - Mohr-Coulomb failure criterion	CO 1	1
5.2	Mohr circle method for determination of principal planes and stresses– relationship between shear parameters and principal stresses	CO 1 & CO 4	1
5.3	Numerical problems	CO 4	1
5.4	Brief discussion of Laboratory tests - Triaxial compression test - UU, CU and CD tests - Total and effective stress strength parameters	CO 2 & CO 4	1
5.5	Unconfined compression test, Direct shear test and vane shear test – Applicability	CO 2 & CO 4	1
5.6	Numerical problems	CO 4	1
5.7	**Stability of finite slopes** - Toe failure, base failure, slip failure	CO 1	1
5.8	Swedish Circle Method : ϕ=0 analysis and c-ϕ analysis - Friction circle method	CO 1 & CO 4	1

5.9	Taylor's Stability number - Stability charts - Numerical Problems	CO 1 & CO 4	1

CET206	TRANSPORTATION ENGINEERING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	4	0	0	4	2019

Preamble

Objective of the course is to introduce the principles and practice of Highway,Railway, Harbour and dock, Tunnel and Airport Engineering.

Prerequisite: Nil

Course Outcomes:

	Description
CO No.	At the end of the course, students will be able to:
CO 1	Apply the basic principles of Highway planning and design highway geometric elements
CO 2	Apply standard code specifications in judging the quality of highway materials; designing mixes and pavements
CO 3	Explain phenomena in road traffic by collection, analysis and interpretation of traffic data through surveys; creative design of traffic control facilities
CO 4	Understand about railway systems, tunnel, harbour and docks
CO 5	Express basics of airport engineering and design airport elements

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (marks)
	Test 1 Marks	Test 2 Marks	
Remember	**7.5**	**7.5**	**30**
Understand	**7.5**	**7.5**	**30**
Apply	**5**	**5**	**20**
Analyse	**5**	**5**	**20**
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

End Semester Examination Pattern:

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

Sample Course Level Assessment Questions:

1**Course Outcome 1 (CO1):**While aligning a highway in a built up area, it was necessary to provide a horizontal curve of radius 300 m for a design speed 65Km/hr, length of wheel base-6m and pavement width 10.5m. Assume rate of introduction of super elevation as 1 in 100 and super elevation is provided by rotating about centre line. Design super elevation, extra widening of pavement and length of transition curve.

2 Course Outcome 2 (CO2): Design a flexible pavement for two lane single carriage way for present traffic 1200 commercial vehicles per day, period of construction= 3 yrs, annual traffic growth = 7.5%, Design CBR = 7%, Design life = 15 yrs. Use IRC method.

3 Course Outcome 3 (CO3): Traffic in a congested multilane highway lane is observed to have an average spacing of 200 ft,and an average headway of 3.8s. Estimate the rate of flow, density and speed of traffic in this lane.

4 Course Outcome 4 (CO4): What are the different types of signals according to location? Illustrate with the help of neat sketch.

5 Course Outcome 5 (CO5): The total length of a runway is 1000 m. The elevation at distance 0,200 m, 400 m, 600 m, 800 m and 1000 m are 100.0 m, 99.2 m, 101.0 m, 101.8 m, 101.4 m and 101.0 m respectively. What will be the effective gradient of runway?

Syllabus

Module	Contents	Hours
1	Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural area, Requirements and factors controlling alignment of roads Introduction to geometric design of highways, Design controls and criteria, Design of highway cross section elements, Design of horizontal alignment - Stopping sight distance, Overtaking sight distance, super elevation, transition curve, length and shift of transition curve, extra widening. Vertical alignment (introduction only)	10
2	Introduction to highway materials, Desirable properties and testing of road aggregates, bituminous materials and sub grade soil. Introduction of flexible and rigid pavements, Factors influencing the design of flexible pavements, Design of flexible pavements by CBR method and IRC 37: 2018. Construction of bituminous pavements	10
3	Introduction to traffic engineering, Traffic characteristics, Capacity and Level of Service, Design Speed, Traffic surveys, Types of road intersections, Traffic control devices (introduction only), Design of isolated signals by Webster's method.	7
4	Railway Engineering - Component parts of a railway track - functions, concept of Gauges, coning of wheels, cant deficiency, compensation of gradients Tunnel Engineering: Tunnel – sections, tunnel surveying - alignment, transferring centre grade into tunnel. Harbours – classification, features, requirements. Break waters - necessity and functions, classification. Docks – Functions and types - dry docks, wet docks (Introduction only)	9
5	Introduction to Airport Engineering, Components of airport, selection of site for airport. Runway orientation, basic runway length and corrections required, Taxiways and aprons.	9

Text Books

1. Khanna, S.K. and Justo C.E.G., Highway Engineering, Nem Chand & Bros., 2015
2. Kadiyali, L. R. and N.B Lal, Principlesand Practices of Highway Engineering, Khanna Publishers, 2013
3. Khanna, S. K. and Arora. M. G., Airport Planning and Design, Nemchand& Bros

4. Mundrey J. S, Railway Track Engineering, Tata McGraw Hill, 2009
5. Rangawala, S.C. , Railway Engineering, Charotor Publishing House
6. Rao G. V, Principles of Transportation and Highway Engineering, Tata McGrawHill, 1996
7. Srinivasan,R., Harbour, Dock & Tunnel Engineering, Charotor Publishing House, 28e, 2016

References

1. Horonjeff R. andMcKelvy, F., Planning and Design of Airports, McGraw Hill, 5e, 2010
2. IRC: 37-2018, Guidelines for the Design of Flexible Pavements, IRC 2018, New Delhi
3. O' Flaherty, C.A (Ed.)., Transport Planning and Traffic Engineering, Elsevier, 1997
4. Rangwala, S. C., Airport Engg. Charotar Publishing Co., 16e, 2016
5. Yoder, E. J and Witczak, M. W, Principles of Pavement Design, John Wiley & Sons, 1991
6. Bindra, S.P., A course in Docks and Harbour Engineering, DhanpatRai& Sons
7. Chandra, S. and Agarwal, M.M., Railway Engineering, Oxford University Press, New Delhi, 2008
8. Saxena, S. C and Arora, S. P, Railway Engineering, DhanpatRai& Sons, 7e, 2010
9. Subhash C. Saxena, Railway Engineering, DhanpatRai& Sons

Course Content and lecture Schedule:

No.	Topic	Course Outcome	No. of Hrs
1	**Module 1**		Total: 10
1.1	Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural area, Requirements and factors controlling alignment of roads.	CO1	2
1.2	Introduction to geometric design of highways, Design controls and criteria, Design of highway cross section elements	CO1	2
1.3	Design of horizontal alignment - Stopping sight distance, Overtaking sight distance, super elevation, transition curve, length and shift of transition curve, extra widening. Vertical alignment (introduction only)	CO1	6
2	**Module 2**		Total: 10
2.1	Introduction to highway materials, Desirable properties and testing of road aggregates, bituminous materials and sub grade soil.	CO2	3
2.2	Introduction of flexible and rigid pavements, Factors influencing the design of flexible pavements, Design of flexible pavements by CBR method and IRC 37 : 2018	CO2	4
2.3	Construction of bituminous pavements	CO2	3
3	**Module 3**		Total: 7
3.1	Introduction to traffic engineering, Traffic characteristics, Capacity and Level of Service, Design Speed, Traffic surveys, Types of road intersections,	CO3	4
3.2	Traffic control devices (introduction only), Design of isolated signals by Webster's method.	CO3	3
4	**Module 4**		Total: 9
4.1	Railway Engineering - Component parts of a railway track - functions, concept of Gauges, coning of wheels, cant deficiency, compensation of gradients	CO4	5
4.2	Tunnel Engineering: Tunnel – sections, tunnel surveying - alignment, transferring centre grade into tunnel.	CO4	2
4.3	Harbours – classification, features, requirements. Break waters - necessity and functions, classification. Docks – Functions and types - dry docks, wet docks (Introduction only)	CO4	2
5	**Module 5**		Total: 9
5.1	Introduction to Airport Engineering, Components of airport, selection of site for airport.	CO5	3
5.2	Runway orientation, basic runway length and corrections required, Taxiways and aprons.	CO5	6

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

Course Code: **CET 206**

Course Name: **TRANSPORTATION ENGINEERING**

Model Question Paper

Marks:100 Duration: 3 hrs

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

1. With a sketch, explain typical cross sectional layout of a two lane road in urban areas.
2. What is meant by reaction time? What is its role in Geometric design of highways?
3. Outline the IRC 37-2018 recommendations for determining the thickness of Flexible pavements.
4. Differentiate flexible and rigid pavements
5. How would you draw the fundamental diagram of traffic flow
6. Explain grade separated intersections and discuss the advantages and limitations
7. Analyse the concept of negative superelevation with suitable explanations
8. Write short note on i) Littoral Drift ii) offshore moorings
9. Enumerate the various factors which would be kept in view while selecting suitable site for an airport.
10. What are taxiways?

PART B
(Answer one full question from each module)

11. a) Enumerate the factors governing the width of carriage way. State the IRC specifications for width of carriage way for various classes of roads. (10)
    b) Write a brief note on classification of highways in India. (4)

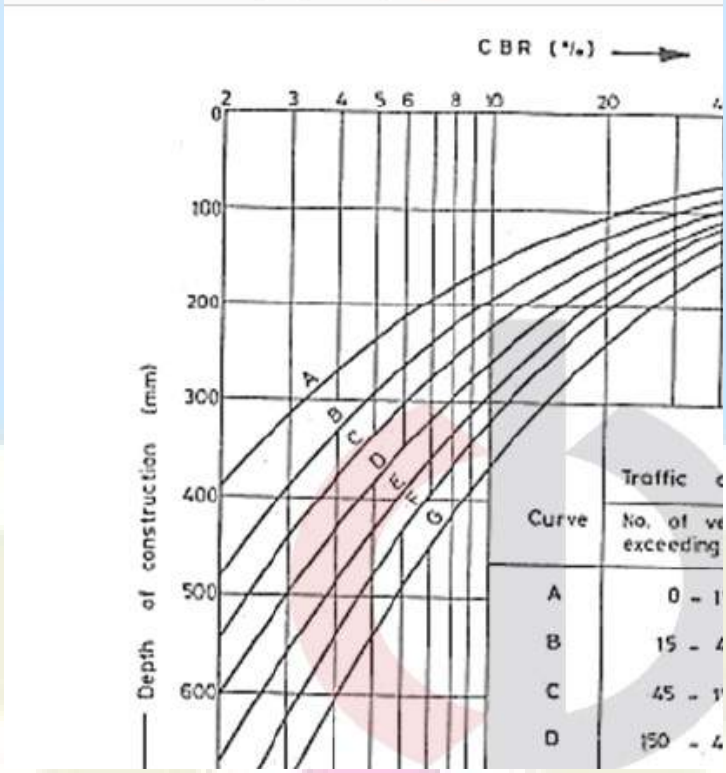
OR

12 a) Calculate the stopping sight distance on a highway for a design speed of 100 kmph. (6)
   b) What is super elevation? Explain the design steps of super elevation. (8)

12. a) Explain the construction practices of the following bituminous base courses.
    1) Bituminous macadam
    2) Penetration macadam (6)

b) The soil subgrade sample was obtained from the project site and the CBR testsconducted at field density gave the following readings. Draw the load penetration curve and determine the CBR value and find the total thickness of the pavement by CBR method as recommended by IRC for commercial vehicles 1500 per day,with 7% growth rate. The pavement construction is to be completed in threeyears after last traffic count.(Use the standard design chart provided) (8)

Penetration (mm)	Load (kg)	Penetration (mm)	Load (kg)
0.0	0.0	3.0	60.0
0.5	6.0	4.0	70.0
1.0	17.0	5.0	77.0
1.5	30.0	7.5	89.0
2.0	42.0	10.0	100.0
2.5	55.0	12.5	115.0



OR

14a) Explain with sketches the various types of failures and their causes in rigid pavements?(10)

b) List out the desirable properties of aggregates to be used in pavementconstruction. Also specify various tests for judging the suitability of aggregates.(4)

15a) What are the advantages and disadvantages of traffic signals? (8)

b) What is (i) Saturation flow, (ii) Lost time, and (iii) Phase in a signal design? (6)

OR

16 a) Define the basic terms basic capacity, possible capacity and practical capacity and analyze its importance in traffic engineering. (6)

b) Evaluate the factors affecting level of service of a multilane highway. (8)

17 a) Analyse various types of gradient used on railway track. What is grade compensation and why is it necessary? (6)

b) State the natural and meteorological phenomena a harbour engineer has to study and briefly mention the effects of these phenomena (8)

OR

18 a) What are the different systems of controlling the movement of trains? Explain the working of absolute block system (8)

b) Write notes on lining of tunnels (6)

19a) Describe the various markings on runways with sketches. (6)

b) Explain with sketches the basic patterns of runway configurations. (8)

OR

20 a) What are the primary functions of air traffic control? (4)

b) The length of a runway under standard conditions is 1500m. The airport is to beprovided at an elevation of 110m above mean sea level. The airport referencetemperature is 320C. Following data refers to the proposed longitudinal section ofrunway. Determine the corrected length of runway. (10)

End to end of runway (m)	Grade (%)	End to end of runway (m)	Grade (%)
0 to 300	+1	1500 to 1800	+1
300 to 900	-0.2	1800 to 2100	-0.3
900 to 1500	+0.5		

CEL 202	MATERIAL TESTING LAB - I	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2019

Preamble: The course aims to enrich the understanding of the fundamental concepts of mechanics of deformable bodies through systematic experimental techniques for the estimation of various mechanical properties of engineering materials.

Prerequisite: Engineering Physics, Mechanics of Materials. Knowledge in use of Vernier caliper and micrometer screw gauge expected.

General Instructions to Faculty:

1. Any 12experimentsout of 15 need to be performed mandatorily. Virtual Lab facility [11] cannot be used to substitute the conduct of these mandatory experiments.
2. The laboratory should have possession of modern testing equipment such as strain gauges, LVDTs, load cells and data acquisition systems at least for demonstration purposes
3. Periodic maintenance and calibration of various testing instruments needs to be made.
4. Use of data visualization packages needs to promoted for making various plots.

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

Course Outcome	Course Outcome Description
CO 1	The understand the behaviour of engineering materials under various forms and stages of loading.
CO 2	Characterize the elastic properties of various materials.
CO3	Evaluate the strength and stiffness properties of engineering materials under various loading conditions.

Mapping of course outcomes with program outcomes:

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

Course Level Assessment Questions

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

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

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks
(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipment and trouble shooting) : 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

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

References

1. S.P. Timoshenko, *History of Strength of Materials*, Dover publications, 1953
2. Egor P. Popov, Engineering Mechanics of Solids, Pearson, 1998.
3. IS 1608 (2005): Metallic Materials – Tensile testing at Ambient temperature, 3rd Revision, July 2008
4. IS 1598 (1977): Method for Izod Impact test of Metals, 2nd reprint, September 1986.
5. IS 1499 (1977) : Method for Charpy Impact test (U-Notch) for metals, 3rd reprint, March 1992.

6. IS 5242 (1979) Method of Test for determining Shear Strength of Metals, 1st revision, 2006.
7. IS 1500 (2005): Method for Brinell Hardness Test for Metallic Materials, 3rd revision, 2005.
8. IS 1501 (2002) : Method for Vickers hardness Test for Metallic Materials.
9. IS 1717 (2012): Metallic Materials – Wire – Simple Torsion Test, 3rd revision, 2012.
10. IS 883 (1994): Design of Structural Timber in Building- Code of Practice, Reaffirmed 2005)
11. www.vlab.co.in

SYLLABUS

Exercise 1. Study on stress-strain characteristics of mild steel and by conducting uniaxial tension test on rod specimens

Exercise 2. Study on stress-strain characteristics of tor steel by conducting uniaxial tension test on rod specimens

Exercise 3. Study on estimation of shear capacity of mild steel specimen by conducting a double shear test on rod specimen.

Exercise 4. Study on flexural behaviour of steel by conduction of test on RSJ (I cross section)

Exercise 5. Study on torsional behaviour and estimation of modulus of rigidity of steel by conducting torsion test on rod specimens

Exercise 6. Study on estimation of modulus of rigidity of steel and brass / copper materials utilizing the principles of torsional vibrations.

Exercise 7. Study on estimation of toughness properties of steel specimens by conducting (a) Izod &(b) Charpy impact tests.

Exercise 8. Study on estimation of hardness properties of engineering materials such as brass, aluminium, copper, steel etc.by performing Brinell hardness test

Exercise 9. Study on estimation of Hardness properties of engineering materials such as brass, aluminium, copper, steel etc.by performing

9.1 Rockwell hardness test

9.2 Vicker's hardness test

Exercise 10. Study on estimation of modulus of rigidity of steel by performing tension tests on spring specimens.

Exercise 11. Study on estimation of modulus of rigidity of steel by performing compression tests on spring specimens

Exercise 12. Study on flexural behaviour of timber material by performing tests on beam specimens.

Exercise 13. Study on estimation of compression strength of timber specimen.

Exercise 14. Experiment on verification of Maxwell's reciprocal theorem

Exercise 15. Bend &rebend test on mild steel specimen

Optional Exercises:

Study/ demonstration of :

- Fatigue test on steel rod specimen
- Strain gauges and Load cells
- Elastic buckling modes of column under different boundary conditions

CEL 204	FLUID MECHANICS LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2019

Preamble: The course is designed to train the students to familiarize and understand the different flow measurement equipment's and their procedures. Students will be introduced to a team working environment where they develop the necessary skills of experimentation techniques for the study of flow phenomena in channels/pipes.

Prerequisite: Fluid Mechanics and Hydraulics

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

Course Outcome (CO)	Course Outcome Description
CO 1	Apply fundamental knowledge of Fluid Mechanics to corresponding experiments
CO 2	Apply theoretical concepts in Fluid Mechanics to respective experiments
CO 3	Analyse experimental data and interpret the results
CO 4	Document the experimentation in prescribed manner

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

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

Course Level Assessment Questions

Assessment Pattern

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

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

General Instructions:

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

Reference Books:

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

List of Exercises/ Experiments (Any 12 experiments out of 15 need to be performed mandatorily. Lab experiments may be given considering 12 sessions of 3 hours each)

1. Study of taps, valves, pipe fittings, gauges, Pitot tubes, water meters and current meters.
2. Calibration of Pressure gauges
3. Determination of metacentric height and radius of gyration of floating bodies.
4. Verification of Bernoulli's theorem
5. Hydraulic coefficients of orifices and mouth pieces under constant head method and time of emptying method.
6. Calibration of Venturimeter

7. Calibration of Orifice meter
8. Calibration of water meter.
9. Calibration of rectangular rectangular notch
10. Calibration of triangular notch.
11. Time of Emptying through orifice
12. Plotting Specific Energy Curves in Open Channel flow
13. Study of Parameters of Hydraulic Jump in Open channel Flow.
14. Determination of friction co-efficient in pipes
15. Determination of loss co-efficient for pipe fittings

SEMESTER -4

MINOR

CET282	COURSE NAME BUILDING DRAWING	CATEGORY	L	T	P	CREDIT
		VAC	2	2	0	4

Preamble: Objective of the course is to give exposure to building rules, impart training in visualisation and planning of various types of buildings and their components.

Prerequisite: Engineering Graphics

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

CO 1	The student will be able to understand building drawing, scales and methods of dimensioning
CO 2	The student will be able draw the details of panelled door, glazed windows, joint details of roof truss
CO 3	The student will be able to draw plan and sectional elevation of reinforced concrete staircase
CO 4	Understand the basic concepts and methods of building drawing using AutoCAD Software
CO 5	The student will be able to prepare site plan, service plan, Septic tank and soak pit - detailed drawing

Mapping of course outcomes with program outcomes

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

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: ESE will be of **3 hour** duration on A2 size answer booklet and will be for 100 marks. (only manual drafting for ESE). 5 descriptive type questions of 2 marks each, one from each module. 2 drawing questions of 45 marks each, with choice from 4, from any 4 modules.

Syllabus

Module 1

General – Study of IS Codes of practice on building drawing – Scales- method of dimensioning.

Sectional plan, sectional elevation, front view and joint details of Panelled door and Glazed windows.

Module 2

Types of Roof- Roofing- Elevation and joint details-Roof truss in steel sections.

Types of Stairs- Plan and sectional elevation of reinforced concrete staircase.

Module 3

Building rules- Two storied and multi-storeyed building- Plan, section and elevation.

Public buildings like offices, bank, dispensary etc.

Module 4

Building rules -Industrial building- Plan, section and elevation.

Preparation of site plan and service plan.

Module 5

Preparation of Septic tank and soak pit -detailed drawing.

Course Content and lecturer Schedule:

No.	Course Plan	Course Outcome	No. ofHrs
	Module 1:		
1.1	General – Study of IS Codes of practice on building drawing	CO1	2
1.2	Scales- method of dimensioning		2
1.3	Sectional plan, sectional elevation, front view and joint details of	CO2	
	(a)Panelled doors		2
1.4			
1.5	(b)Glazed windows		2
	Module 2:		
2.1	Types of Roofs	CO2	2
2.2	Roof truss in steel sections		2
2.3	Types of Stairs	CO3	2
2.4	Reinforced concrete staircase		2
	Module 3:		
3.1	Building rules		2
	Plan, section and elevation of	CO4	
3.2	(a) Two storied building		2
3.3	(b) multi-storeyed building		2
3.4	(c) Public building		2

4.1 4.2	**Module 4:** Building rules and type of Industrial building Plan elevation and section of industrial building	CO4	2 2
4.3 4.4	Preparation of site plan service plan	CO5	2 2
5.1	**Module 5:** Preparation of Septic tank and soak pit -detailed drawing	CO5	2

Reference Books

1. National Building Code of India.

2. Kerala Municipal Building Rules.

3. Dr. Balagopal T.S. Prabhu, Building Drawing and Detailing, Spades Publishers, Calicut.

Model Question Paper

QP CODE: Reg No:----------

Name:----------

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

Course Code**: CET282**

BUILDING DRAWING

Max. Marks: 100 Duration: 3 hours

Part A
(Answer all questions; each question carries 2 marks)

1. Draw neat sketches for following lines; (a) Section line (b) Hidden line (c) Dimension line (d) Extension line
2. What are the major components of a steel truss?
3. What is the difference between waist slab and folded slab stair?
4. What is FAR and FSI?
5. State the importance of site plan and openings schedule in civil engineering drawing.

PART B
(Answer Two full question, each question carries 45 marks)

6. (a) Draw the elevation and sectional view of a double leaf and six paneled door of size 2000x1200 mm

OR

(b)Plan a RCC stair case for a room dimension 450 cm x 300 cm. Draw plan view and sectional view. Take floor height =3m.

7. (a) a single stored residential house with the following requirements & draw plan, elevation and section.

(i) Verandah (ii) Bed room (3 no's), one with attached toilet (iii) living hall (iv) kitchen (v) work area (vi) common toilet

OR

(b) Draw the plan and elevation of a small hospital for the following requirements;

(i) Doctor's room (2) (ii) causality

(iii) Dressing area (iv) Pharmacy

(v) Laboratory (vi) Store room

(vii) Toilets (vii) ward (5 bed)

CET284	INTRODUCTION TO TRANSPORTATION ENGINEERING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		VAC	4	0	0	4	2019

Preamble

Objective of the course is to introduce the principles and practice of Highway,Traffic Engineering and Transportation Planning.

Prerequisite: Nil

Course Outcomes:

	Description
CO No.	At the end of the course, students will be able to:
1	**Discuss** the basic characteristics of Highways and basics of geometric design.
2	**Analyse** the features of highway materials , various types of pavements, and construction techniques
3	**Interpret** the basics of traffic characteristics, describe how to conduct traffic surveys and interpret data, understand the various traffic control devices
4	**Establish** the basics of different modes of transportation and their characteristics including rail, water and air.
5	**Appraise**Travel Demand Estimation process and the sustainable transportation measures and its application through promoting public transportation modes.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (marks)
	Test 1 Marks	Test 2 Marks	
Remember	**10**	**10**	**30**
Understand	**10**	**10**	**30**
Apply	**5**	**5**	**40**
Analyse			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

End Semester Examination Pattern:

The question consists of two parts- Part A and Part B. Part A consists of 5 questions with 5 marks for each (one questions from each module). Part B consists of two questions from each module, out of which one has to be answered. Each question carries 15 marks and can have maximum 3 subdivisions.

Course Level Assessment Questions:

Course Outcome 1 (CO1): What are the basic requirements for an ideal highway alignment? Describe thefactors considered in finalising the alignment.

Course Outcome 2 (CO2): Describe the specifications of materials and construction steps of bituminous concrete pavements.

Course Outcome 3 (CO3): Explain the effect of various vehicular characteristics on traffic stream behaviour.

Course Outcome 4 (CO4): Sketch the typical layout of an airport showing the location of taxiways, runways, apron and terminal building for a two open parallel runways.

Course Outcome 5 (CO5): What are the options available in present day society to make transportation sustainable? What are the steps to be adopted by the stakeholders to implement it in India?

SYLLABUS

Mod	Contents	Hrs
1	Introduction to Transportation Engineering, Role of transportation in the development of a society, Classification of roads, Typical cross sections of roads in urban and rural area, Introduction to geometric design of highways, highway cross section elements	9
2	Introduction of flexible and rigid pavements. Introduction to highway materials, Desirable properties and testing of road aggregates, bituminous materials and sub grade soil. Construction of bituminous pavements and rigid pavements (Basics only)	9
3	Introduction to traffic engineering, Traffic characteristics, Capacity and Level of Service, Design Speed, Traffic signals and markings, Types of road intersections, Traffic control devices (introduction only)	8
4	Railway Engineering - Component parts of a railway track - functions, concept of Gauges, coning of wheels Harbours – classification, features, requirements. Break waters - necessity and functions, classification. Docks – Functions and types - dry docks, wet docks (Introduction only) Airport Engineering:- Components of airport and airport layout, Runway orientation, Taxiways, aprons. and Terminal Building (Introduction only)	12
5	Transportation Planning:-Need for Transportation planning, Transport- land use interaction, Travel Demand Estimation –(Introduction only) Sustainable urban transport; issues and challenges, Emerging concepts in sustainable transportation: green vehicles and green roads, green and alternate fuels;	7

Text Books

1. Khanna, S.K. & Justo E.G., Highway Engineering, Nem Chand & Bros., 2000
2. Kadiyali, L. R., Traffic Engineering& Transportation Planning, Khanna Publishers, 2017
3. Khanna, S. K. and Arora. M. G., Airport Planning and Design, Nemchand& Bros
4. Rangawala, S.C. , Railway Engineering, Charotar Publishing House
5. Rao G. V, Principles of Transportation and Highway Engineering, Tata McGrawHill, 1996
6. Srinivasan,R., Harbour, Dock & Tunnel Engineering, Charotar Publishing House, 28e, 2016

References

1. Partho Chakraborty and Animesh Das, Principles of Transportation Engineering,
2. IRC: 37-2001, Guidelines for the Design of Flexible Pavements, IRC 2001, New Delhi
3. IRC:37-2012, Tentative Guidelines for the Design of Flexible Pavements , PHI, 2017
4. O' Flaherty, C.A (Ed.)., Transport Planning and Traffic Engineering, Elsevier, 1997
5. C S Papacostas and P D Prevedouros, Transportation Engineering and Planning, 2007
6. Yoder, E. J &Witezak, M. W, Principles of Pavement Design, John Wiley & Sons, 1991
7. Sustainable Urban Transport Shanghai Manual – A Guide for Sustainable Urban Development in the 21st Century

Course Content and lecture Schedule:			
No.	**Topic**	**Course Outcome**	**No. of Hrs**
1	**Module 1**		Total: 9
1.1	Introduction to Transportation Engineering, Role of transportation in the development of a society, Various fields of Transportation Engineering	CO1	2
1.2	Classification of roads, Typical cross sections of roads in urban and rural area,	CO1	3
1.3	Introduction to geometric design of highways, highway cross section elements, Horizontal alignment and Vertical alignment (introduction only)	CO1	4
2	**Module 2**		Total:9
2.1	Introduction of flexible and rigid pavements	CO2	2
2.2	Introduction to highway materials, Desirable properties and testing of road aggregates	CO2	4
2.3	Construction of bituminous pavement sand rigid pavements (Basics only)	CO2	3
3	**Module 3**		Total: 8
3.1	Introduction to traffic engineering, Traffic characteristics	CO3	2
3.2	Capacity and Level of Service, Design Speed	CO3	2
3.3	Traffic signals and markings	CO3	2
3.4	Types of road intersections, Traffic control devices (introduction only)	CO3	2
4	**Module 4**		Total: 12
4.1	Railway Engineering - Component parts of a railway track functions, concept of Gauges, coning of wheels	CO4	4
4.2	Harbours – classification, features, requirements. Break waters - necessity and functions, classification. Docks – Functions and types - dry docks, wet docks (Introduction only)	CO4	4
4.3	Introduction to Airport Engineering, Components of airport, Runway orientation, Taxiways and aprons and Terminal Building	CO4	4
5	**Module 5**		Total: 7
5.1	Need for Transportation planning, Transport- land use interaction	CO5	1
5.2	Travel Demand Estimation - Steps in 4 stage planning process	CO5	2
5.3	Sustainable urban transport; issues and challenges	CO5	1
5.4	Policy options for urban transport- Push and pull approach, NMT planning, Transit oriented development	CO5	2
5.5	Emerging concepts in sustainable transportation: green vehicles and green roads, green and alternate fuels;	CO5	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code:**CET284**
Course Name: **INTRODUCTION TO TRANSPORTATION ENGINEERING**
Model Question Paper

Marks:100 Duration: 3 hrs

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

1 What is the role of roads in Indian economy?
2 Explain briefly the classification of highways in India.
3 Differentiate flexible and rigid pavement
4 Differentiate tack coat and prime coat. What are the objectives of application of each?
5 Distinguish between traffic capacity, basic capacity and practical capacity.
6 Discuss about the requirements of traffic control devices.
7 List and define the component parts of a railway track.
8 What are the detrimental forces acting on a break water?
9 List the role of transportation planning to society
10 What are the advantages of green fuel?

(3 x 10=30 marks)

PART B
(Answer one full question from each module)

11	a.	What are the factors controlling the alignment of highways? Explain the influence each of them in detail?	7
	b.	Discuss about the various cross section elements to be considered in the geometric design of highways?	7
		OR	
12	a.	Design the rate of super elevation for a horizontal highway curve of radius 500 m and speed 100 kmph	7
	b.	What is overtaking sight distance? Derive the equation for OSD.	7
13	a.	Differentiate flexible and rigid pavements. Sketch a typical section for each.	7
	b.	Discuss the desirable properties of aggregates used for road construction.	7
		OR	
14	a.	Discuss any three properties of bitumen and their effect on the performance ofbituminous mixes in pavements.	7
	b.	What are the factors to be considered in design of flexible pavements and indicate their significance?	7

15	a.	Explain the effect of various vehicular characteristics on traffic stream behaviour.	7
	b.	Draw a typical Speed-flow diagram and indicate the Levels of service as per IRC.	7
		OR	
16	a.	What are the advantages and disadvantages of traffic signals?	7
	b.	Enumerate the basic types of intersections and basic principles involved.	7
17	a.	Explain with neat sketches the concept of coning of wheels.	7
	b.	How are harbours classified? Explain with sketches any two types.	7
		OR	
18	a	Distinguish between wet docks and dry docks? What are its functions?	7
	b.	Enumerate the factors that are to be considered for site selection of an airport?	7
19	a.	Enumerate how land use and transportation planning are inter related.	7
	b.	Briefly explain the various stages in travel demand estimation	7
		OR	
20	a.	What are the ways to overcome the issues and challenges in transportation?	7
	b.	How can green vehicles and green roads contribute to sustainable transportation?	7

CET 286	Climate Change and Hazard Mitigation	Category	L	T	P	Credit	Year of Introduction
		VAC	4	0	0	4	2019

Preamble: The course is designed to build climate literacy among students, encourages them to adapt to climate change related issues. It helps learners to understand the fundamentals of climate, climate change and climate models, evaluate the impacts of climate change on ecosystems, and empower learners to take appropriate actions to adopt various hazard mitigation measures.

Pre-requisite: Nil

Course outcome

After the course, the student will able to:

CO1	Explain the basic physical principles of the global climate system.
CO2	Describe the large-scale climatic changes which has influenced the ecosystem.
CO3	List actions in key sectors to mitigate hazards due to climate change.
CO4	Identify international initiatives which support countries to address the climate change challenges.
CO5	Analyse the impact of climate change on ecosystem.

CET 256 Climate Change and Hazard Mitigation		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	3					2	1							1	
	CO2	3					2	1								
	CO3	3					2	1								
	CO4	3					2									
	CO5	3					2	1								

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

Qn No	Question	Marks	Course outcome (CO) Assessed
	Part A		
1	Define climate system.	3	CO1
2	How does Albedo affect climate of a place?	3	CO1
3	Briefly explain El Nino and its effects.	3	CO2

4	What is carbon cycling?	3	CO2
5	Describe about General Circulation Models.	3	CO5
6	Comment on Ocean Acidification.	3	CO5
7	Discuss the mission of Intergovernmental Panel on Climate Change.	3	CO4
8	What is Montreal Protocol?	3	CO4
9	Briefly explain Carbon dioxide Capture and Storage.	3	CO3
10	Discuss the importance of bio energy crops.	3	CO3
	Part B **(Answer ANY ONE FULL question from each module)**		
	Module I		
11(a)	What is the general circulation of the atmosphere?	7	CO1
11(b)	How does the general circulation affect the earth's climate?	7	CO1
12(a)	What is the composition and structure of the atmosphere?	7	CO1
12(b)	Explain the significance of water in the atmosphere on climate of earth.	7	CO1
	Module II		
13(a)	State and explain Global Warming Potential.	7	CO2
13(b)	Briefly explain Gandhian ideas on Global warming.	7	CO2
14(a)	Describe the importance of Greenhouse effect on global climate system.	7	CO2

14(b)	Discuss the role of carbon dioxide in Greenhouse effect	7	CO2
	Module III		
15	Briefly explain the impact of climate change on surface temperature and precipitation.	14	CO5
16	Describe the different uncertainties inherent in the projection of climate. .	14	CO5
	Module IV		
17	Enumerate the international initiatives to address climate change challenges and explain any two.	14	CO4
18(a)	Outline the structure of the Intergovernmental Panel on Climate Change.	4	CO4
18(b)	Explain the comprehensive Assessment Reports of IPCC.	10	CO4
	Module V		
19 (a)	Explain hazards due to climate change and describe the possible mitigation measures to it.	14	CO3
20 (a)	Discuss the concept of energy efficiency in buildings in response to climate change.	5	CO3
20 (b)	Discuss the impact of climate change on Ecosystem and its adaptation measures.	9	CO3

Model Question Paper

Reg No.:…….. **QP CODE:……..**

Name:……

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

Course Code: CET 286

Climate Change and Hazard Mitigation

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

Part A

(Answer all questions; each question carries 3 marks)

1. Define climate system.
2. How does Albedo affect climate?
3. Briefly explain El Nino and its effects.
4. What is carbon cycling?
5. Describe about General Circulation Models.
6. Comment on Ocean Acidification.
7. Discuss the mission of Intergovernmental Panel on Climate Change.
8. What is Montreal Protocol?
9. Briefly explain Carbon dioxide Capture and Storage.
10. Discuss the importance of bio energy crops.

Part B

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

Module I

11. a) What is the general circulation of the atmosphere? (7 Marks)

    b) How does the general circulation affect the earths climate? (7 Marks)

OR

12. a) What is the composition and structure of the atmosphere? (7 Marks)

    b) Explain the significance of water in the atmosphere on climate of earth. (7 Marks)

Module II

13. (a) State and explain Global Warming Potential. (7 Marks)

    (b) Briefly explain Gandhian ideas on Global warming. (7 Marks)

OR

14. (a) Describe the importance of Greenhouse effect on global climate system. (7 Marks)

    (b) Discuss the role of carbon dioxide in Greenhouse effect. (7 Marks)

Module III

15. Explain the impact of climate change on surface temperature and precipitation. (14 Marks)

OR

16. Describe the different uncertainties inherent in the projection of climate. (14 Marks)

Module IV

17. Enumerate the international initiatives to address climate change challenges and explain any two. (14 Marks)

OR

18. a) Outline the structure of the Intergovernmental Panel on Climate Change. (4 Marks)

    b) Explain the comprehensive Assessment Reports of IPCC. (10 Marks)

Module V

19. Explain hazards due to climate change and describe the possible mitigation measures to it. (14 Marks)

OR

20. (a) Discuss the concept of energy efficiency in buildings in response to climate change. (5 Marks)

    (b) Discuss the impact of climate change on Ecosystem and its adaptation measures. (9 Marks)

Course Code: CET 286
Climate Change and Hazard Mitigation

Module I

Introduction to Earth's Climate System: Basic concepts- Radiation, Albedo, Emissivity, scales of motion, large-scale motion, general circulation, troposphere-stratosphere transport. Atmospheric structure and thermodynamics: pressure, density, composition, temperature structure, water in the atmosphere. Atmospheric photochemistry and chemical kinetics

Module II

Hurricanes and Global warming: Global Ocean Circulation - El Nino and its effects - Paleo- indicators of climate -The Nature of Storms—cyclones, tornadoes and hurricanes. Greenhouse effect-greenhouse gases-sources of emission - The Role of Carbon Dioxide, The Earth's Carbon Reservoirs, Carbon Cycling-Climate and Weather Global warming potential - Effects of Global warming- Gandhian ideas on global warming.

Module III

Climate data and Models: Equations of atmospheric fluid mechanics, energy equation, turbulence, mixing length models, Atmospheric chemical transport and general circulation models. Analyses of climate data. Climate projections and their uncertainties. Impacts of climate change on Surface temperature, Precipitation, Ocean pH, Sea-level and Arctic sea-ice extent.

Module IV

International initiatives to address the climate change challenges: History of Earth's climate – 1970s (IIASA, DOE), 1980s, Startup of the U.N IPCC, Mission of the IPCC, The Framework Convention on Climate Change, The Kyoto Protocol to the Framework Convention, Earth Summit, Montreal Protocol. Policy Analyses, Internationally Adopted Emissions Restrictions.

Module V

Climate Change Adaptation & Mitigation Measures: Adaptation to climate change in the fields of Ecosystems and biodiversity - Agriculture and food security, land use, forestry, human health, water supply, sanitation and infrastructure. Hazards due to climate change

and Mitigation Measures: Extreme weather events. Mitigation measures in sectors vital to humanity (food, water, health): Brief explanation of - Carbon dioxide capture and storage (CCS), Bio-energy crops, Energy efficiency in buildings.

Text Books

- Mark Masli, Climate Change: A Very Short Introduction, Oxford University Press, 2014.
- Jan C van Dam, Impacts of Climate Change and Climate Variability on Hydrological Regimes, Cambridge University Press, UK, 2003.
- Trenberth, K.E. (Editor), 1992: *Climate System Modeling*, Cambridge University Press, Cambridge, U.K.

References

- IPCC second assessment report - Working Group I Report, The Science of climate change, 1995.
- IPCC fourth assessment report - The AR4 synthesis report, 2007
- IPCC fourth assessment report - Working Group I Report, The physical Science Basis, 2007.
- IPCC fourth assessment report - Working Group II Report, Impacts, Adaptation and Vulnerability, 2007.
- IPCC fourth assessment report - Working Group III Report Mitigation of Climate change, 2007
- IPCC fifth assessment report - The AR5 synthesis report, 2014

Course Code: CET 286
Climate Change and Hazard Mitigation
Course content and Schedule of Lecture (sample)

Module	Topic	Course outcome addressed	No of Hours
Module I (9 Hours)			
1.1	Introduction to Earth's Climate System: Basic concepts	CO1	1
1.2	Radiation, Albedo, Emissivity,	CO1	1
1.3	Scales of motion, large-scale motion	CO1	1
1.4	General circulation, troposphere-stratosphere transport	CO1	1
1.5	Atmospheric structure and thermodynamics	CO1	1
1.6	Pressure, density, composition	CO1	1

1.7	Temperature structure, water in the atmosphere	CO1	1
1.8	Atmospheric photochemistry	CO1	1
1.9	Chemical kinetics	CO1	1
Module II (9 Hours)			
2.1	Hurricanes and Global warming: Global Ocean Circulation	CO2	1
2.2	El Nino and its effects - Paleo- indicators of climate	CO2	1
2.3	The Nature of Storms—cyclones, tornadoes and hurricanes	CO2	1
2.4	Greenhouse effect-greenhouse gases-sources of emission	CO2	1
2.5	The Role of Carbon Dioxide, The Earth's Carbon Reservoirs	CO2	1
2.6	Carbon Cycling-Climate and Weather Global warming potential	CO2	1
2.7	Effects of Global warming	CO2	1
2.8	Effects of Global warming	CO2	1
2.9	Gandhian ideas on global warming.	CO2	1

Module III (9 Hours)			
3.1	Climate data and Models; Equations of atmospheric fluid mechanics, energy equation, turbulence	CO5	1
3.2	Mixing length models	CO5	1
3.3	Atmospheric chemical transport	CO5	1
3.4	General circulation models	CO5	1
3.5	Analyses of climate data	CO5	1
3.6	Climate projections and their uncertainties	CO5	1
3.7	Impacts of climate change on Surface temperature, Precipitation	CO5	1
3.8	Impacts of climate change on Ocean pH, Sea-level and Arctic sea-ice extent	CO5	1

3.9	Impacts of climate change on Ocean pH, Sea-level and Arctic sea-ice extent	CO5	1
Module IV (9 Hours)			
4.1	International initiatives to address the climate change challenges	CO4	1
4.2	History of Earth's climate – 1970s (IIASA, DOE), 1980s	CO4	1
4.3	Startup of the U.N IPCC, Mission of the IPCC	CO4	1
4.4	The Framework Convention on Climate Change	CO4	1
4.5	The Kyoto Protocol to the Framework Convention	CO4	1
4.6	Earth Summit	CO4	1
4.7	Montreal Protocol	CO4	1
4.8	Policy Analyses	CO4	1
4.9	Internationally Adopted Emissions Restrictions	CO4	1

Module V (9 Hours)			
5.1	Climate Change Adaptation & Mitigation Measures	CO3	1
5.2	Adaptation to climate change in the fields of Ecosystems and biodiversity	CO3	1
5.3	Agriculture and food security, land use, forestry, human health	CO3	1
5.4	Water supply, sanitation and infrastructure	CO3	1
5.5	Hazards due to climate change and Mitigation Measures: Extreme weather events	CO3	1
5.6	Mitigation measures in sectors vital to humanity (food, water, health)	CO3	1
5.7	Carbon dioxide capture and storage (CCS)	CO3	1
5.8	Bio-energy crops, Energy efficiency in buildings.	CO3	1
5.9	Energy efficiency in buildings.	CO3	1

SEMESTER -4

HONOURS

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

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

Prerequisite: Mechanics of Solids

Course Outcomes:

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

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Part A

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

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

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

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

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

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

Part B

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

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

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

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

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

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

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

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

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

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

Model Question Paper
CET292 - Advanced Mechanics of Solids

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

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

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

Syllabus

Module 1 Stress in 3-D

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

Module 2 Strain in 3-D

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

Module 3 Elements of Theory of Elasticity

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

Module 4 Failure and Failure criteria

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

Module 5 Torsion

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

Text Books

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

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

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

Reference Books

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

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

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

Lecture Plan – Advanced Mechanics of Solids

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

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

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

Preamble

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

Prerequisite: NIL

Course Outcomes:

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

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

End Semester Examination Pattern:

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

Sample Course Level Assessment Questions:

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

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

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

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

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

Syllabus

Module 1

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

Module 2

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

Module 3

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

Module 4

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

Module 5

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

TEXT BOOKS

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

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

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

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

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

REFERENCES

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

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

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

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

Course Content and lecture Schedule:

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

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

Course Code:**CET 294**

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

Marks:100 Duration: 3 hrs

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

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

(3 x 10 = 30)

PART B
(Answer one full question from each module)

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

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

OR

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

b) Explain grading of bitumen
(4)

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

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

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

OR

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

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

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

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

OR

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

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

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

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

OR

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

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

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

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

OR

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

    b) Explain Life Cycle Cost Analysis
    (6)

CET 296	GEOGRAPHICAL INFORMATION SYSTEMS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	4	0	0	4	2019

Preamble: Goal of this course is to expose the students to the fundamental concepts and components of Geographical Information System (GIS). After successful completion this course, students will be able to identify the requirements for the development of GIS module for various applications.

Prerequisite: Nil

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

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

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	7.5	7.5	30
Understand	7.5	7.5	30
Apply	10	10	40
Analyse			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

End Semester Examination Pattern:

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

Part A contains 10 questions with 2 questions from each module and each question shall carry 3 marks. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions

Syllabus

Module 1

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

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

Tutorial- Introducing any GIS software and its tools.

Module 2

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

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

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

Module 3

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

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

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

Module 4

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

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

Tutorial exercises: working with a surface / terrain models

Module 5

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

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

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

Text Books:

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

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

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

References:

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

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

Course Contents and Lecture Schedule:

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

Sample Course Level Assessment Questions

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

CO1

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

CO2

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

CO3

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

CO4

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

Model Question Paper

QP CODE:

Reg No.:_____ Name:_____

ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CET 296

Course Name : GEOGRAPHICAL INFORMATION SYSTEMS

Max. Marks: 100 Duration: 3 hours

PART A

(Answer all questions)

(10 ×3 = 30)

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

PART B

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

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

(7 + 7)

or

12 (i) illustrate any three applications of GIS

(ii) Compare cylindrical projections and conical projections

(6+ 8)

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

(iii) Highlight the role of digitisation in map preparation

(7 + 7)

or

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

(ii) Compare continuous raster and discrete raster

(6+ 8)

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

(ii) Illustrate any two raster data operations

(7 + 7)

or

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

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

(6 + 8)

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

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

(7 + 7)

or

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

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

(7+7)

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

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

(6 + 8)

or

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

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

(7+ 7)