SEMESTER -3

CET201	MECHANICS OF SOLIDS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	3	1	0	4	2019

Preamble:

Mechanics of solids is one of the foundation courses in the study of structural systems. The course provides the fundamental concepts of mechanics of deformable bodies and helps students to develop their analytical and problem solving skills. The course introduces students to the various internal effects induced in structural members as well as their deformations due to different types of loading. After this course students will be able to determine the stress, strain and deformation of loaded structural elements.

Prerequisite: EST 100 Engineering Mechanics

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	Recall the fundamental terms and theorems associated with mechanics of linear elastic deformable bodies.	Remembering
CO2	Explain the behavior and response of various structural elements under various loading conditions.	Understanding
CO3	Apply the principles of solid mechanics to calculate internal stresses/strains, stress resultants and strain energies in structural elements subjected to axial/transverse loadsand bending/twisting moments.	Applying
CO4	Choose appropriate principles or formula to find the elastic constants of materials making use of the information available.	Applying
CO5	Perform stress transformations, identify principal planes/ stresses and maximum shear stress at a point in a structural member.	Applying
CO6	Analyse the given structural member to calculate the safe load or proportion the cross section to carry the load safely.	Analysing

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	15
Understand	10	10	15
Apply	30	20	60
Analyse		10	10
Evaluate			
Create			

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment (Sample) Questions

CO1: Recall the fundamental terms and theorems associated with mechanics of linear elastic deformable bodies.

1. What is proportionality limit? What is its significance?
2. Sketch the stress-strain curve of mild steel and mark the salient points
3. What is Poisson's ratio?
4. What is Bulk modulus of Elasticity? Write the relationship between Bulk modulus of elasticity and Young's modulus of elasticity.
5. What is pure bending? Give an example.
6. What is point of contraflexure?
7. What are the limitations of Euler's formula to calculate the buckling load of slender columns.
8. What is strain energy?
9. What is complementary shear stress?
10. What are principal stresses and principal planes?

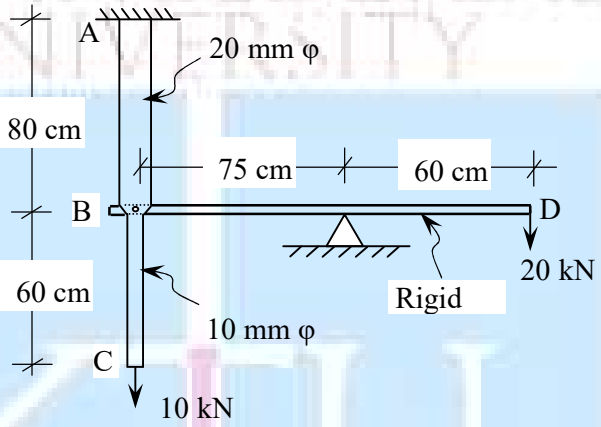
CO2: Explain the behavior and response of various structural elements under various loading conditions.

1. Explain how the deformation of an axially loaded bar with uniformly varying cross section is calculated?
2. Explain the behavior of mild steel under gradually increasing tensile load.
3. Explain the effect of temperature change on a composite bar made of two materials.
4. How do you compute the maximum stress induced in a bar due to impact load?
5. Explain the concept of BM and SF in beams, with the help of a cantilever beam subjected to uniformly distributed load over the whole span.
6. List three important assumptions used in the theory of pure bending and explain their significance.
7. Explain the behavior of slender columns under axial compressive load.
8. Distinguish between short and long columns with reference to their behavior under axial compression.
9. Explain how the limitation of Euler's formula to calculate buckling load of columns is addressed in Rankine's formula.

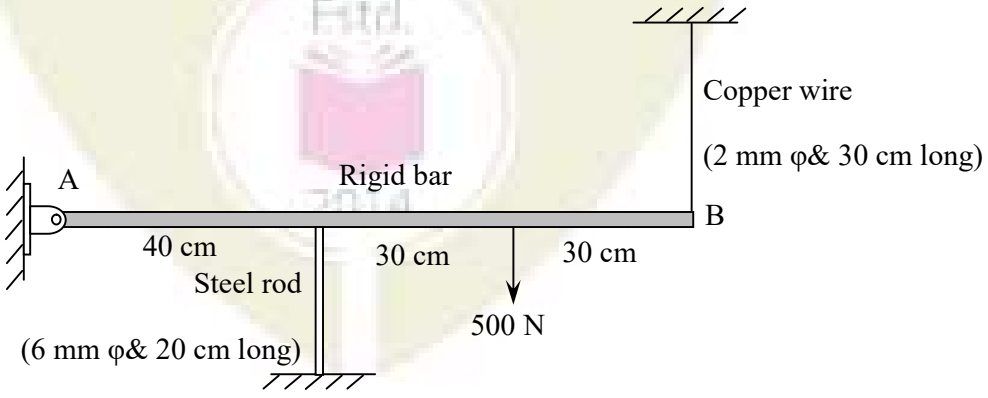
CO3: Apply the principles of solid mechanics to calculate internal stresses/strains, stress resultants and strain energies in structural elements subjected to axial/transverse loads and bending/twisting moments.

1. A steel flat of cross section 25 mm × 6 mm carries a tensile load of 12 kN. Find the stress induced in the cross section. If a circular hole of diameter 12 mm is made (normal to the flat surface), find the maximum stress induced in the cross section.

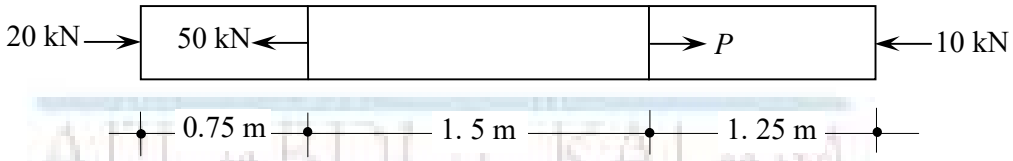
2. The bar ABC shown in figure is made of steel and has circular cross section. The bar BD is rigid. Find the stresses in portions AB and BC and the vertical deflection at C. Take E = 210 GPa.



3. A rigid barABof length 100 cm, hinged at one end is supported by a steel rod and a copper wire as shown. Find the stresses induced in the rod and wire due to a downward load acting at 70 cm from the hinged end of the bar. Calculate the vertical deflection at B also. Modulus of elasticity of steel and copper are 200 GPa and 80 GPa respectively. Neglect the weight of the rigid bar.

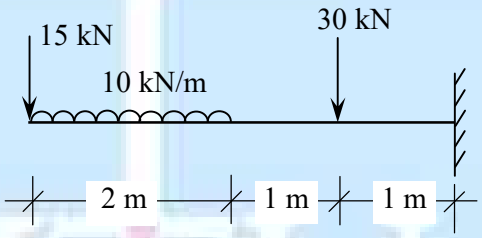


4. A 32 mm diameter steel bar is subjected to forces as shown in figure. Find the value of P necessary for equilibrium and stresses in different segments. Also calculate the final length of the bar. Take E = 200 GPa.

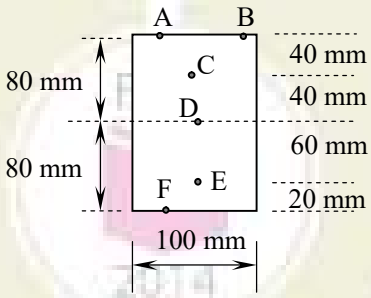


4. A cylindrical bar with two sections of lengths 50 cm and 25 cm, and diameters 20 mm and 15 mm respectively is subjected to an axial pull such that the maximum stress is 150MN/m^2. Calculate the strain energy stored in the bar. E=200GN/m^2

5. Draw the SFD and BMD of the beam shown.



6. Figure shows the cross section of a beam. Find the stresses (both magnitude and nature) at points A,B,C,D,E and F, if the section carries a BM of 12 kNm. Draw the variation of stress across the cross section.
Also calculate the shear stress at these points if the cross section carries a SF of 50 kN.



CO4: Choose appropriate principles or formula to find the elastic constants of materials making use of the information available.

1. A concrete cylinder of diameter 150 mm and height 300 mm is tested under compression. It was found that the diameter was increased by 0.0102 mm and the height was decreased by 0.165 mm under the action of a compressive load of 200 kN. Calculate the modulus of elasticity, Poisson's ratio, bulk modulus and shear modulus of concrete.

2. A tension test is carried out on a mild steel bar of 10 mm diameter. The bar yields under a load of 20 kN, it reaches a maximum load of 40 kN and breaks at 25 kN. The diameter of the bar at breaking was found to be 7 mm. The increase in length of the bar over a gauge length of 50 mm was found to be 0.029 mm under a load of 10 kN. Estimate (a) Young's modulus, (b) yield strength, (c) ultimate strength and (d) actual breaking strength

CO5: Perform stress transformations, identify principal planes/stresses and maximum shear stress at a point in a structural member.

1. A bar of 12 mm diameter carries an axial pull of 15 kN. Find the normal and shear stress on a plane inclined at 60° with the axis of the bar. What is the maximum shear stress induced in the bar and the inclination of the corresponding plane?
2. At a certain point in a strained material, the stresses on two planes at right angles to each other are 50 MPa (tensile) and 80 MPa (compressive). They are accompanied by a shear stress of magnitude 20 MPa. Find the principal stresses and locate their planes. Also find the maximum shear stress and resultant stress on the plane of maximum shear stress.

CO6: Analyse the given structural member to calculate the safe load or proportion the cross section to carry the load safely.

1. A timber beam 150 mm × 200 mm is used as a simply supported beam of span 3 m. Find the maximum uniformly distributed load that can be applied in addition to a concentrated load of 5 kN acting at the mid span, if the maximum bending stress in the beam is not to exceed 8 N/mm^2. Neglect self weight of beam.
2. A 3 m long cantilever beam of rectangular section is required to carry a udl of 10 kN/m over the whole span. If the maximum bending stress is limited to 12 N/mm^2, find the dimensions of the cross section assuming depth to width ratio as 2.
3. A cast iron test beam 25 mm square in section and 700 mm long is simply supported at ends. It fails under a central load of 2300 N. What load at the free end will break a cantilever of the same material 50 mm wide × 100 mm deep and 1500 mm long?
4. A solid circular shaft transmits 80 kW power at 190 rpm. Calculate the diameter of the shaft if the twist in the shaft is not to exceed 1° in 2 m length of shaft and shear stress is limited to 60 MPa. Take G = 100 GPa.

SYLLABUS

Module – 1

Review of statics, Concept of stress and strain – types, Stress – strain relation - Hooke's law, Young's modulus of elasticity.
Stress-strain diagram of mild steel.
Factor of safety, working stress.
Axially loaded bars with uniform cross section–stress, strain and deformation.
Deformation of axially loaded bars with varying cross section and bars with varying axial loads.
Statically indeterminate systems (number of unknowns restricted to two).

Module – 2

Temperature effects, temperature stress in composite bars.
Shear stress and shear strain, Modulus of rigidity, simple shear, punching shear.
Lateral strain, Poisson's ratio,volumetric strain.
Bulk modulus of elasticity, relationships between elastic constants.
Strain energy – concept.Strain energy due to normal stress.
Strain energy in bars carrying axial loads.
Instantaneous stress in bars due to gradual, sudden and impact loads.Strain energy due to shear stress.
Stresses in thin cylinders and spheres due to internal pressure.

Module – 3

Beams – different types. Types of loading on beams. Concept of bending moment and shear force.
Relationship between intensity of load, shear force and bending moment.
Shear force and bending moment diagrams of cantilever beams, simply supported beams and overhanging beams for different type of loads. Point of contraflexure.

Module – 4

Theory of simple bending, assumptions and limitations.
Calculation of normal stress in beams, moment of resistance
Shear stress in beams.
Beams of uniform strength.
Strain energy due to bending – calculation of strain energy in beams.
Differential equation for calculating the deflection of beams. (Introduction and demonstration only. Students are not expected to solve deflection problems.)

Module – 5

Stresses on inclined sections for uniaxial and biaxial stress fields.
Principal stresses and principal planes in 2D problems, maximum shear stress.
Strains along principal directions.
Mohr's circle of stress for 2D problems.
Short columns – direct and bending stress. Kern of a section.
Slender columns – Euler's buckling load, slenderness ratio, limitation of Euler's formula.
Rankines formula.
Torsion of circular and hollow circular shafts, Power transmitted by circular shafts and hollow circular shafts.Strain energy due to torsion.

Text Books:

1. H. J. Shah andS. B. Junnarkar, Mechanics of Structures Vol - I, Charotar Publishing House.
2. R. K. Bansal, A Text book of Strength of Materials, Laxmi Publications (P) Ltd, New Delhi.
3. B. C. Punmia, Ashok K. Jain, Arun Kumar Jain, Mechanics of Materials, Laxmi Publications (P) Ltd, New Delhi.

References:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall International Series.
2. James M Gere, S.P. Timoshenko, Mechanics of Materials, CBS Publishers and Distributors, New Delhi.
3. R.C. Hibbeler, Mechanics of Materials (edn.10), Pearson
4. S. Ramamrutham and R. Narayanan, Strength of Materials, Dhanpat Rai Publishing Co (P) Ltd.
5. Rattan, Strength of Materials, McGraw Hill Education India.

Lecture Plan –Mechanics of Solids

Module	*Topic*	*Course Outcomes addressed*	*No. of Lectures*
1	**Module I : Total lecture hours : 8**		
1.1	Review of statics – equilibrium conditions, free body diagrams, centroid, moment of inertia.	-	1
1.2	Concept of stress, types of stresses. Concept of strain ,types of strains. Stress – strain relation - Hooke's law, Young's modulus of elasticity.	CO1, CO2, CO4	1
1.3	Stress-strain ($\sigma - \varepsilon$) diagram of mild steel – proportional limit, yield point, ultimate stress, fracture. True and engineering $\sigma - \varepsilon$ curve, idealized $\sigma - \varepsilon$ curves. Factor of safety, working stress.	CO1, CO2	1
1.4	Axially loaded bars with uniform cross section– calculation of stress, strain and deformation.	CO2, CO3	1
1.5	Deformation of axially loaded bars with varying cross section. Stepped bars, bars with tapering cross section	CO3	1
1.6	Deformation of axially loaded bars with varying axial loads – elongation of bars under self weight, elongation/contraction of uniform/stepped bars.	CO3	1
1.7	Statically indeterminate systems – analysis of axially loaded composite bars (with maximum two materials)	CO3, CO6	1
1.8	Analysis of indeterminate systems with axial load carrying members (number of unknowns restricted to two). (Example: Assessment Level Question 3 of CO3)	CO3, CO6	1

2	**Module II : Total lecture hours : 8**		
2.1	Temperature effects, temperature stress in composite bars.	CO2, CO3	1
2.2	Shear stress and shear strain, Modulus of rigidity, simple shear, punching shear.	CO1, CO2, CO3, CO4	1
2.3	Lateral strain, Poisson's ratio, volumetric strain. Volumetric strain of rectangular bar, circular bar and sphere. Volumetric strain expressed in terms of strains along three mutually perpendicular directions.	CO2, CO3	1
2.4	Bulk modulus of elasticity, relationships between elastic constants.	CO1, CO4	1
2.5	Strain energy – concept. Resilience, modulus of resilience and proof resilience. Strain energy due to normal stress.Calculation of total strain energy in bars carrying axial loads. Strain energy due to shear stress.	CO1,CO2, CO3	2
2.6	Instantaneous stress in bars due to gradual, sudden and impact loads.	CO1,CO2, CO3	1
2.7	Stresses in thin cylinders and spheres due to internal pressure	CO1, CO2, CO3	1
3	**Module III : Total lecture hours : 8**		
3.1	Beams – different types. Types of loading on beams. Concept of bending moment and shear force. Shear force and bending moment diagrams.	CO1, CO2	1
3.2	Relationship between load, shear force and bending moment. Demonstration using simple examples.	CO1	1
3.3	Shear force and bending moment diagrams of cantilever beams subjected to point load, concentrated moments, uniformly distributed and uniformly varying loads.	CO2	2
3.4	Shear force and bending moment diagrams of simply supported beams subjected to point load, concentrated moment, uniformly distributed and uniformly varying loads.	CO2	2
3.5	Shear force and bending moment diagrams of overhanging beams subjected to point load, concentrated moment and uniformly distributed loads. Point of contraflexure.	CO1, CO2	2
4	**Module IV : Total lecture hours : 9**		
4.1	Theory of simple bending – derivation of equation, assumptions and limitations.	CO1, CO2	1
4.2	Variation of bending stress across the cross section. Maximum bending stress, section modulus, moment of resistance.	CO1, CO2	1
4.3	Calculation of normal stress in beams. Problems involving bending stress	CO3	1

4.4	Shear stress in beams – derivation of equation. Variation of shear stress across the cross section. (Derivation required for rectangular, circular and triangular sections only)	CO1, CO2	1
4.5	Calculation of shear stress- problems involving shear stress.	CO3	1
4.6	Calculation of allowable loads in beams based on bending stress and shear stress criteria.	CO6	1
4.7	Proportioning beam sections to carry given load without exceeding the allowable bending stress and/ shear stress. Beams of uniform strength.	CO6	1
4.8	Strain energy due to bending – calculation of strain energy in beams. (Cantilever and simply supported beams subjected to point load and uniformly distributed load)	CO1, CO2, CO3	1
4.9	Moment-curvature relation. Basic differential equation for calculating the deflection of beams. Simple example to calculate deflection of beams (such as cantilever beam with point load at free end) for demonstration purpose.	CO1	1
5	**Module V : Total lecture hours : 12**		
5.1	Stresses on inclined planes for uniaxial and biaxial stress fields. Element subjected to pure shear.	CO3	2
5.2	Principal stresses and principal planes in 2D problems, maximum shear stress. Strains along principal directions.	CO1, CO3, CO5	2
5.3	Mohr's circle of stress for 2D problems.	CO3, CO5	1
5.4	Short columns – direct and bending stress. Kern of a section (concept only).	CO1,CO2, CO3	1
5.5	Slender columns –Buckling, Euler's buckling load for columns with pinned ends. Eulers' buckling load for columns with different end conditions (no derivation required). Effective length of columns with different end conditions.	CO1,CO2, CO3	2
5.6	Slenderness ratio, limitation of Euler's formula. Rankine's formula. Safe load calculation using Rankine's formula (demonstration only).	CO1,CO2, CO3	1
5.7	Torsion of circular and hollow circular shafts, assumptions, derivation of torsion equation. Variation of stress across the cross section.Polar modulus.	CO1,CO2, CO3	1
5.8	Power transmitted by circular shafts and hollow circular shafts. Proportioning the shafts to transmit a given power based on shear stress and angle of twist considerations Strain energy due to torsion.	CO3, CO6	2

MODEL QUESTION PAPER

Reg.No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CET201

Course Name: MECHANICS OF SOLIDS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions; each question carries 3 marks.

1. a) Define the terms (i) proportionality limit, (ii) ultimate stress (ii) working stress.
   b) Explain, how the deformation of an axially loaded bar with uniformly varying cross section is calculated?
   c) Explain the effect of temperature change on a composite bar made of two materials.
   d) What is Bulk modulus of Elasticity? Write the relationship between Bulk modulus of elasticity and Young's modulus of elasticity.
   e) What is the relationship between intensity of load, SF and BM?
   f) Explain the concept of BM and SF in beams, with the help of a cantilever beam subjected to uniformly distributed load over the whole span.
   g) What is pure bending? Give an example.
   h) List three important assumptions used in the theory of pure bending and their significance.
   i) What are principal stresses and principal planes?
   j) Distinguish between short and long columns with reference to their behavior under axial compression.

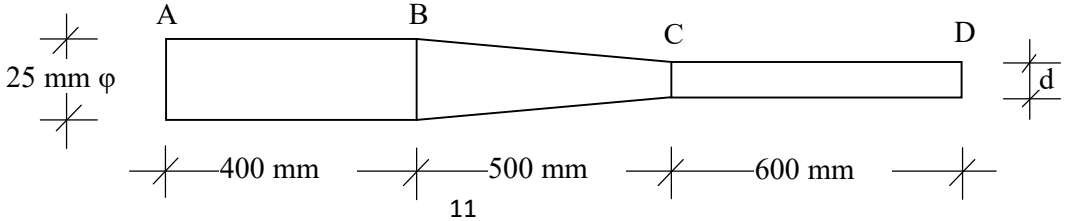
(10×3 marks = 30 marks)

PART B

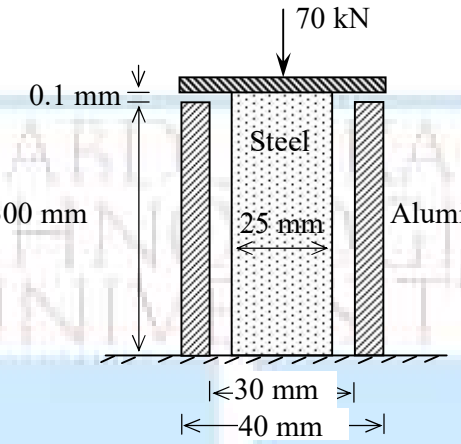
Answer one full question from each module; each full question carries 14 marks.

Module I

2. A bar of circular cross section has three segments as shown in figure. The portion AB has a constant diameter of 25 mm. The portion BC has diameter 25 mm at B and tapers uniformly to diameter '*d* ' at C. The portion CD has a constant diameter of '*d* '. The bar was found to elongate by 0.539 mm under an axial tension of 20 kN. Find the value of '*d* '. Take Young's modulus of elasticity of the material as 200 GPa.



3. A steel rod of 25 mm diameter is placed in a hollow aluminium cylinder with internal diameter 30 mm and external diameter 40 mm. The steel rod projects 0.1 mm as shown. The bar carries a compressive force of 70 kN through a rigid bearing plate. Find the stresses in steel and aluminium bars. E_s = 200 GPa and E_{al} = 120 GPa



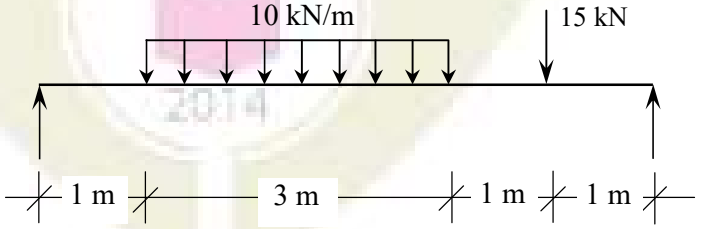
Module II

4. A concrete cylinder of diameter 150 mm and height 300 mm is tested under axial compression. It was found that the diameter was increased by 0.0102 mm and the height was decreased by 0.165 mm under the action of a compressive load of 200 kN. Calculate the modulus of elasticity, Poisson's ratio, bulk modulus and shear modulus of concrete.

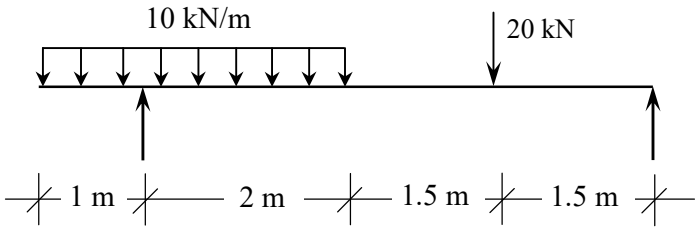
5. A compound bar is made of a central steel plate 60 mm wide and 10 mm thick to which copper plates 40 mm wide and 5mm thick are rigidly connected on each side. The length of the bar at normal temperature is 1 m. If the temperature is raised by 80°C, determine the stress in each metal and the change in length. $Es = 2\times10^5$ N/mm^2 ,$\alpha_S = 12\times10^{-6}$ /°C, $Ec = 1.05\times10^5$ N/mm^2 and $\alpha_C = 17.5\times10^{-6}$ /°C.

Module III

6. Draw the SFD and BMD of the beam loaded as shown in figure. Find the maximum BM and locate the point of maximum BM also.



7. An overhanging beam is loaded as shown. Draw SFD and BMD. Locate the point of contraflexure also.



Module IV

8. a) A simply supported beam of triangular cross section, having width 160 mm and height 210 mm, carries a udl of 2 kN/m over a span of 4m. Find the maximum tensile and compressive stresses induced. Draw the variation of stress across the cross section. (10 marks)

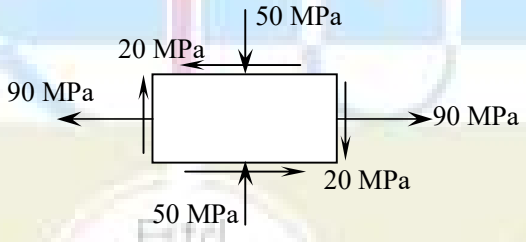
   b) Calculate the total strain energy due to bending in a cantilever beam of span L carrying a point load W at its free end. (4 marks)

9. a) A timber beam 150 mm × 200 mm (width = 150 mm) is used as a simply supported beam of span 3 m. Find the maximum uniformly distributed load that can be applied in addition to a concentrated load of 5 kN acting at the mid span, if the maximum bending stress and shear stress in the beam are not to exceed 15 N/mm^2 and 2 N/mm^2 respectively. Neglect self weight of beam. (10 marks)

   b) What is beam of uniform strength? Give an example. (4 marks)

Module V

10. A point in a strained body is subjected to stresses as shown in figure. Find the principal stresses and maximum shear stress. Also locate the principal planes and planes of maximum shear stress, with respect to the vertical plane. Calculate the strains along the direction of the principal stresses also. Take E = 200 GPa and ν = 0.25.



11. A solid circular shaft transmits 80 kW power at 190 rpm. Calculate the diameter of the shaft if the twist in the shaft is not to exceed 1^o in 2 m length of shaft and shear stress is limited to 60 MPa. Take G = 100 GPa.

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CET 203	Fluid Mechanics and Hydraulics	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

Preamble: Goal of this course is to expose the students to the fundamental concepts of fluid mechanics, hydraulics of pipes and open channels and to enhance the problem solving skills. The concepts learned will help in applying them for the design of hydraulic structures and to real world fluid flow problems.

Pre-requisite: Elementary mathematics, concepts in engineering mechanics

Course outcome

After the course, the student will able to:

CO1	Recall the relevant principles of hydrostatics and hydraulics of pipes and open channels
CO2	Identify or describe the type, characteristics or properties of fluid flow
CO3	Estimate the fluid pressure, perform the stability check of bodies under hydrostatic condition
CO4	Compute discharge through pipes or estimate the forces on pipe bends by applying hydraulic principles of continuity, energy and/or momentum
CO5	Analyze or compute the flow through open channels, perform the design of prismatic channels

CET 203 Fluid Mechanics and Hydraulics		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	CO1	2	2										
	CO2	2	2										
	CO3	3	3				1						
	CO4	3	3				1						
	CO5	3	3	2									

Assessment pattern

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

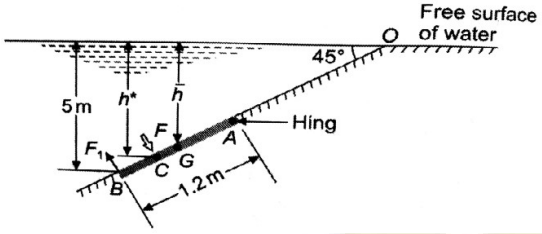
Evaluate			
Create			

Continuous Internal Evaluation Pattern:

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

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

Qn No	Question	Marks	Course outcome (CO) Assessed
	Part A (Answer ALL Questions)		
1	Explain the method of estimation of hydrostatic force on curved surfaces	3	CO1
2	Compare the use of piezometer and manometer for pressure measurement	3	CO1
3	Explain the experimental method of determination of metacentric height	3	CO1
4	Define streamline, streakine and pathline	3	CO2
5	Explain the use and principle of Pitot tube	3	CO1
6	Obtain the discharge equation of a large rectangular orifice	3	CO2
7	Explain conveyance and section factor for uniform flow and their practical applications	3	CO1
8	Obtain the condition for maximum velocity through	3	CO1

	circular channels		
9	State the assumptions involved in the derivation of dynamic equation of gradually varied low	3	CO1
10	Explain the classification of hydraulic jumps based on Froude's Number	3	CO1
	Part B **(Answer ANY ONE FULL question from each module)**		
	Module I		
11(a)	Differentiate gauge pressure, atmospheric pressure and absolute pressure	4	CO1
11(b)	A U-tube manometer is used to measure the pressure of water in a pipeline which is in excess of atmospheric. The left limb is connected to the pipeline and right limb is open to atmosphere. The free surface of mercury in the right limb is in level with the centre line of the pipe and the level difference of mercury in the limbs of the manometer is 20 cm. Compute the water pressure in the pipeline. If the pressure of water is increased by 50 %, compute the manometric reading.	10	CO3
12(a)	Obtain the expression for centre of pressure of a lamina placed in fluid in vertical position	4	CO1
12(b)	An inclined rectangular sluice gate AB 1.2m by 5m as shown in fig is installed to control the discharge of water. The end A is hinged. Determine the force normal to gate applied at B to open it. 	10	CO3
	Module II		
13(a)	Find the acceleration at (1, 2, 3) after 1 sec for a 3D flow given by $u=yz+t$, $v=xz-t$, $w=xy$	6	CO2
13(b)	Derive continuity equation in 3D Cartesian coordinates	8	CO1

14(a)	A solid cylinder 2 m in diameter and 2 m in length floats in water with its axis vertical. If the specific gravity of the material of the cylinder is 0.65, find the metacentric height and comment on the stability of the body	6	CO3
14(b)	Explain the stability conditions of floating bodies and submerged bodies	8	CO1
	Module III		
15	Gasoline (specific gravity 0.82) flows at a rate of 215 l/s in upward direction through an inclined venturimeter fitted to a 300 mm diameter pipe. The venturimeter is inclined at 60^o to vertical and its 150 mm diameter throat is 1.2 m from the entrance along its length. Pressure gauges inserted at the inlet and throat show pressures of 0.141 N/mm^2 and 0.077 N/mm^2 respectively. Compute the coefficient of discharge of the venturimeter. If instead of pressure gauges, the entrance and throat are connected to two limbs of a mercury u-tube manometer, determine the manometric reading.	14	CO4
16	A pipeline of 600 m diameter is 1.5 km long. To increase the discharge, another pipe of same diameter is introduced in parallel to the first pipe, for the second half of length. If f=0.04, and head at inlet is 300 mm, calculate the increase in discharge. Neglect minor losses.	14	CO4
	Module IV		
17(a)	Explain the characteristics of velocity distribution in open channels	4	CO2
17(b)	A lined canal n=0.014 is of trapezoidal section with one side vertical and other with a slope of 1.5H:1 V. If the channel is to deliver 9 m^3/sec when laid on a slope of 0.0002, calculate the dimensions of the efficient section that requires minimum lining.	10	CO5
18(a)	Obtain the discharge equation of a Cipoletti weir	4	CO2
18(b)	A 40 m long weir is divided into 12 equal bays by vertical posts, each 0.6 m wide. Using Francis formula, calculate the discharge over the weir if the head over the crest is 1.2 m and velocity of approach is 2 m/sec	10	CO5
	Module V		
19 (a)	State the characteristics of M type profiles	4	CO2

19 (b)	A very wide rectangular channel carries a discharge of 8 cumecs per m width. The channel has a bed slope of 0.004 and Manning's roughness coefficient 0.015. Find the distance to a section were water depth is 0.9 m using single step method	10	CO5
20 (a)	Show that minimum specific force for a given discharge indicate the critical flow in open channels	4	CO2
20 (b)	The energy loss and Froude number after the jump in a horizontal rectangular channel are 9.00 and 0.12 respectively. Determine the depth before the jump will be and the power lost per m width of the channel	10	CO5

Model Question Paper

Reg No.:..... **QP CODE:.....**

Name:.....

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

Course Code: CET203

Fluid Mechanics and Hydraulics

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

Part A

(Answer all questions; each question carries 3 marks)

1. Explain the method of estimation of hydrostatic force on curved surfaces
2. Compare the use of piezometer and manometer for pressure measurement
3. Explain the experimental method of determination of metacentric height
4. Define streamline, streakline and pathline
5. Explain the use and principle of Pitot tube
6. Obtain the discharge equation of a large rectangular orifice
7. Explain conveyance and section factor for uniform flow and their practical applications
8. Obtain the condition for maximum velocity through circular channels
9. State the assumptions involved in the derivation of dynamic equation of gradually varied low

10. Explain the classification of hydraulic jumps based on Froude's Number

(3 Marks x 10 = 30 Marks)

Part B

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

Module I

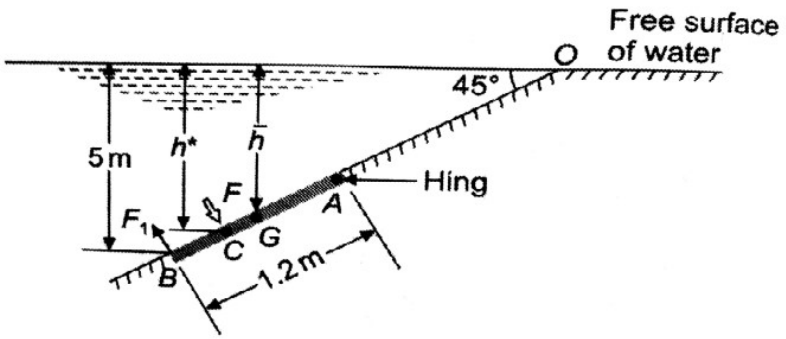
11 (a) Differentiate gauge pressure, atmospheric pressure and absolute pressure (4 Marks)

(b) A U-tube manometer is used to measure the pressure of water in a pipeline which is in excess of atmospheric. The left limb is connected to the pipeline and right limb is open to atmosphere. The free surface of mercury in the right limb is in level with the centre line of the pipe and the level difference of mercury in the limbs of the manometer is 20 cm. Compute the water pressure in the pipeline. If the pressure of water is increased by 50 %, compute the manometric reading. (10 Marks)

OR

12.(a) Obtain the expression for centre of pressure of a lamina placed in fluid in vertical position (4 Marks)

(b) An inclined rectangular sluice gate AB 1.2m by 5m as shown in fig is installed to control the discharge of water. The end A is hinged. Determine the force normal to gate applied at B to open it. (10 Marks)



Module II

13.(a) Find the acceleration at (1, 2, 3) after 1 sec for a 3D flow given by $u=yz+t$, $v=xz-t$, $w=xy$

(6 Marks)

(b) Derive continuity equation in 3D Cartesian coordinates (8 Marks)

OR

14. (a) A solid cylinder 2 m in diameter and 2 m in length floats in water with its axis vertical. If the specific gravity of the material of the cylinder is 0.65, find the metacentric height and comment on the stability of the body. (6 Marks)

(b) Explain the stability conditions of floating and submerged bodies (8 Marks)

Module III

15. Gasoline (specific gravity 0.82) flows at a rate of 215 l/s in upward direction through an inclined venturimeter fitted to a 300 mm diameter pipe. The venturimeter is inclined at 60^o to vertical and its 150 mm diameter throat is 1.2 m from the entrance along its length.Pressure gauges inserted at the inlet and throat show pressures of 0.141 N/mm^2 and 0.077 N/mm^2 respectively. Compute the coefficient of discharge of the venturimeter. If instead of pressure gauges, the entrance and throat are connected to two limbs of a mercury u-tube manometer, determine the manometric reading. (14 Marks)

OR

16. A pipeline of 600 m diameter is 1.5 km long. To increase the discharge, another pipe of same diameter is introduced in parallel to the first pipe, for the second half of length. If f=0.04, and head at inlet is 300 mm, calculate the increase in discharge. Neglect minor losses. (14 Marks)

Module IV

17 (a) Explain the characteristics of velocity distribution in open channels (4 Marks)

(b) A lined canal n=0.014 is of trapezoidal section with one side vertical and other with a slope of 1.5H:1 V. If the channel is to deliver 9 m^3/sec when laid on a slope of 0.0002, calculate the dimensions of the efficient section that requires minimum lining. (10 Marks)

OR

18 (a) Obtain the discharge equation of a Cipoletti weir (4 Marks)

(b) A 40 m long weir is divided into 12 equal bays by vertical posts, each 0.6 m wide. Using Francis formula, calculate the discharge over the weir if the head over the crest is 1.2 m and velocity of approach is 2 m/sec (10 Marks)

Module V

19 (a) State the characteristics of M type profiles (4 Marks)

(b) A very wide rectangular channel carries a discharge of 8 cumecs per m width. The channel has a bed slope of 0.004 and Manning's roughness coefficient 0.015. Find the distance to a section were water depth is 0.9 m using single step method. (10 Marks)

OR

20.(a) Show that minimum specific force for a given discharge indicate the critical flow in open channels. (4 Marks)

(b) The energy loss and Froude number after the jump in a horizontal rectangular channel are 9.00 and 0.12 respectively. Determine the depth before the jump will be and the power lost per m width of the channel. (10 Marks)

Course Code: CET203

Fluid Mechanics and Hydraulics

Syllabus

Module I

Introduction to the subject-Fluid properties (mass density, specific weight, viscosity, specific gravity), Classification of Fluids (prerequisite no questions from this section)

Fluid statics-variation of pressure in a fluid, measurement of fluid pressure using piezometers and manometers, U-tube manometers, Forces on immersed plane placed vertical and inclined positions. Hydrostatic force on curved surfaces – Practical application of total pressure on spillway gates.

Module II

Buoyancy and Floatation: Buoyant force, Principle of floatation, stability of floating and submerged bodies, metacentre and metacentric height, analytical and experimental determination of metacentric height

Hydrodynamics- Methods of describing fluid motion, Lagrangian and Eulerian methods, velocity and acceleration, types of fluid flow, description of fluid flow- streamline, pathline and streakline; continuity equation in one, two and three dimensions

Module III

Fluid kinetics-forces considered in describing fluid motion, Derivation of Bernoulli's equation by integration of Euler's equation along a streamline, kinetic energy correction factor, Applications of Bernoulli's equation- Venturimeter, Pitot tube and Orificemeter; Hydraulic

coefficients of orifices and their experimental determination, Discharge through small orifice and large rectangular orifices

Pipe flow- computation of major and minor losses in pipes, hydraulic gradient line and total energy line, pipes in series-equivalent pipe, flow through parallel pipes.

Module IV

Open channel flow – comparison between pipe flow and open channel flow, velocity distribution in open channels, types of channels, type of flow, geometric elements of channel section, uniform flow computations (Chezy's equation, Kutter's and Manning's formula); Most economical sections – rectangular, triangular and trapezoidal channels, condition for maximum discharge and maximum velocity through circular channels, conveyance and section factor
Flow measurement in channels – notches and weirs – Discharge computations using weirs-velocity of approach and end contraction, discharge equations of rectangular weir, triangular weir, trapezoidal and Cipoletti weir, submerged weir, broad crested weir.

Module V

Specific energy- specific energy diagram and discharge diagram, Critical flow and its computation.
Gradually varied flow- Dynamic equation of gradually varied flow-different forms, types and characteristics of water surface profiles in rectangular prismatic channels. Computation of length of water surface profiles by direct step method
Specific force, Rapidly varied flow-Hydraulic jump-conjugate or sequent depths, expression for sequent depths and energy loss for a hydraulic jump in horizontal rectangular channels, types uses and characteristics of hydraulic jump

Text Books

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

References

1. Streeter.V.L. Fluid Mechanics, Mc Graw Hill Publishers.
2. Bruce R Munson, Donald F Young . Fundamentals of Fluid Mechanics, John Wiley & sons, 2011.
3. Jain A. K., Fluid Mechanics, Khanna Publishers, Delhi, 1996.
4. Joseph Katz, Introductory Fluid Mechanics, Cambridge University Press, 2015
5. Arora.K.R. Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, 2005.

6. Narasimhan S., A First Course in Fluid Mechanics, University Press (India) Pvt. Ltd., 2006.
7. Frank.M.White, Fluid Mechanics, Mc Graw Hill, 2013.
8. Mohanty.A.K. Fluid Mechanics, Prentice Hall, New Delhi, 2011
9. Narayana Pillai,N. Principles of Fluid Mechanics and Fluid Machines, University Press, 2011.
10. Kumar.D.N. Fluid Mechanics and Fluid power Engineering, S.K.Kataria & sons, 2013.

Course Code: CET203

Fluid Mechanics and Hydraulics

Course content and Schedule of lecture (sample)

Module	Topic	Course outcome addressed	No of Hours
Module I (9 Hours)			
1.1	Introduction to the subject-Fluid properties (mass density, specific weight, viscosity, specific gravity) Classification of Fluids	CO1	1
1.2	Fluid statics-fluid pressure and variation of pressure in a fluid, Pressure head	CO1	1
1.3	Measurement of pressure using piezometers and manometers	CO3	1
1.4	Problems on pressure measurement	CO3	1
1.5	Tutorial	CO3	1
1.6	Pressure head on immersed plane- vertical and inclined cases	CO3	1
1.7	Problems on estimation of pressure	CO3	1
1.8	Estimation of pressure force acting on curved surfaces	CO1	1
1.9	Tutorial	CO3	1
Module II (9 Hours)			
2.1	Buoyancy, buoyant force, principle of floatation, stability of submerged bodies	CO1	1
2.2	Stability of floating bodies, metacentre and metacentric height-analytical determination	CO1	1
2.3	Metacentric height- experimental determination, problems	CO3	1
2.4	Problems on buoyancy and floatation	CO3	1

2.5	Kinematics of fluids: Methods of describing fluid motion, Lagrangian and Eulerian methods, Types of fluid flow; Description of fluid motion-streamline, streakline and pathline	CO2	1
2.6	Velocity & Acceleration of fluid particle, convective and local acceleration	CO2	1
2.7	Problems on flow properties	CO2	1
2.8	Conservation of mass, Equation of continuity in 1D,2D and 3D	CO2	1
2.9	Tutorial	CO2	1
Module III (9 Hours)			
3.1	Introduction to fluid kinetics – forces acting; Euler's equation of motion and integration of Euler's equation of motion along a streamline- Bernoulli's Equation, Energy correction factor	CO1	1
3.2	Applications of Bernoulli's equation, Venturimeter and orifice meter, Problems	CO4	1
3.3	Problems	CO4	1
3.4	Flow through orifices: types of orifices, Experimental determination of Hydraulic coefficients	CO2	1
3.5	Flow over a sharp edged orifice, Flow through large rectangular orifice and submerged orifices	CO2	1
3.6	Pipe flow: Equations for determination of major and minor energy losses	CO1	1
3.7	Hydraulic gradient and total energy line; pipes in series and parallel	CO1	1
3.8,	Problems on discharge computation	CO4	1
3.9	Tutorial	CO4	1
Module IV (9 Hours)			
4.1	Introduction-difference between pipe flow and open channel flow-types of channels and flow, velocity distribution in open channels	CO1	1
4.2	Geometric elements of channels-computation for simple sections-Uniform flow; Derivation of Chezy's equation	CO1	1
4.3	Manning's and Kutter's Equation, Concept of Conveyance and Section factor, problems	CO5	1
4.4	Problems		1
4.5	Most economical sections-conditions for rectangular, triangular and trapezoidal channels	CO5	1
4.6	Most economical circular channels, Problems	CO5	1
4.7	Flow measurement in channels- Types of weirs flow over rectangular and triangular sharp crested weir; Effect of end contraction and velocity of approach	CO5	1

4.8	Flow over a trapezoidal weir, Cipolletti weir, broad crested weir, submerged weirs	CO5	1
4.9	Tutorial	CO5	1
Module V (9 Hours)			
5.1	Specific energy, Specific energy diagram computation of critical depth	CO5	1
5.2	Problems	CO5	1
5.3	Gradually varied flow-Concept, Forms of GVF equations,	CO5	1
5.4	Types and Characteristics of water surface profiles	CO5	1
5.5	Problems	CO5	1
5.6	Computation of length of water surface profiles by direct step method, Problems	CO5	1
5.7	Specific force, Conjugate depths, Hydraulic jump- Derivation of sequent depth relation in rectangular channels	CO5	1
5.8	Characteristics, types and uses of hydraulic jump, Problems	CO5	1
5.9	Tutorial	CO5	1

CET205	SURVEYING & GEOMATICS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	4	0	0	4	2019

Preamble:
Objective of the course is to impart an awareness on the principles of surveying, various methods and instruments of surveying, errors associated with field measurements and advanced surveying techniques.

Prerequisite: Nil

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

CO 1	Apply surveying techniques and principles of leveling for the preparation of contour maps, computation of area-volume and sketching mass diagram
CO 2	Apply the principles of surveying for triangulation
CO 3	Apply different methods of traverse surveying and traverse balancing
CO 4	Identify the possible errors in surveying and apply the corrections in field measurements
CO 5	Apply the basic knowledge of setting out of different types of curves
CO 6	Employ surveying techniques using advanced surveying equipments

Mapping of course outcomes with program outcomes

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

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	**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:

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): The following perpendicular offsets were taken at 10m intervals from a survey line AB to an irregular boundary line: 2.50, 3.80, 4.33, 6.76, 5.30, 7.25, 8.95, 8.25 and 5.50.Calculate the area in sqm, enclosed between the survey line, the irregular boundary ,the first and the last offsets by i) Simpsons rule ii) Trapezoidal rule.

Course Outcome 2 (CO2): What is meant by satellite station and reduction to centre. From an eccentric station S, 13 metres to the west of the main station B, the following angles were measured. Angle BSC= 75°25'32", Angle CSA = 55°32'20''. The stations S and C are to the opposite sides of the line AB. Calculate the correct angle ABC if the lengths AB and BC are 5288m and 4940m respectively

Course Outcome 3 (CO3): How do you balance a closed traverse with closing error using the graphical method of Bowdich's rule?

Course Outcome 4 (CO4): How is the most probable value in direct observations of equal weights determined?

Course Outcome 5 (CO5): How do you set out a simple curve by Rankine's method of tangential angles. Calculate the necessary data for setting out a curve of 300 m radius. Assume any other data, if required.

Course Outcome 6 (CO6): What are spectral signature curves? Discuss the spectral reflectance of soil, water and vegetation.

Syllabus

Module 1

Introduction to Surveying- Principles, Linear, angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines,Local attraction, Declination, Methods of orientation (by compass and by backsighting)

Levelling: Principles of levelling- Dumpy level, booking and reducing levels, Methods- simple, differential, reciprocal leveling, profile levelling and cross sectioning. Digital and Auto Level, Errors in leveling

Contouring: Characteristics, methods, uses.

Module 2

Area and Volume: computation of area by offsets to base line, by dividing area into number of triangles; volume of level section by prismoidal and trapezoidal formulae.

Mass diagram: Construction, Characteristics and uses

Theodolite survey: Instruments, Measurement of horizontal and vertical angle, principles of stadia and tangential tacheometry (introduction only)

Triangulation: Triangulation figures, Triangulation stations, Inter visibility of stations, Satellite Stations and reduction to centre.

Module 3

Traverse Surveying - Methods of traversing, Checks in closed traverse, Traverse computations, Balancing the traverse- Bowditch's rule, Transit rule, graphical method based on Bowditch's rule, omitted measurements (a line and an angle only)

Theory of Errors – Types, theory of least squares, Weighting of observations, Most probable value, Computation of indirectly observed quantities - method of normal equations.

Module 4

C**urve Surveying** – Elements of simple and compound curves – Methods of setting out (Angular methods only)– Elements of Reverse curve (Introduction only)– Transition curve – length of curve – Elements of transition curve - Vertical curve (Introduction only)

Total Station – concept of EDM, principles and working, advantages and applications

Module 5

Global Positioning Systems-Components and principles, satellite ranging-calculating position, signal structure, application of GPS, GPS Surveying methods-Static, Rapid static, Kinematic methods – DGPS

Remote Sensing : Definition- Electromagnetic spectrum-Energy interactions with atmosphere and earth surface features-spectral reflectance of vegetation, soil and water- Classification of sensors- Active and Passive, Resolution-spatial, spectral radiometric and Temporal resolution, Multi spectral scanning-Along track and across track scanning

Geographical Information System-components of GIS, GIS operations, Map projections-methods, Coordinate systems-Geographic and Projected coordinate systems, Data Types- Spatial and attribute data, Raster and vector data representation

Text Books :

1. Dr. B.C. Punmia , Ashok Kumar Jain &Arun Kumar Jain - Surveying , Laxmi publications (P) Ltd , 2005
2. Chang,K , "Introduction to Geographic Information Systems", Tata McGraw-Hill Publishing Co. Ltd, 2008
3. George Joseph, "Fundamentals of Remote Sensing", University Press, 2003

References :

1. C. Venkatramaiah, Textbook of Surveying, Universities Press (India) Private Limited 2011
2. James M Andersen, Edward M Mikhail, Surveying Theory and Practice, McGraw Hill Education
4. Prof. T.P.Kenetkar&Prof.S.V.Kulkarni - Surveying and Levelling , Pune VidyarthiGriha Prakashan,2004
5. N NBasak, Surveying and Levelling, McGrawHill Education
6. R.Agor - A Text book of Surveying and Levelling, Khanna Publishers, 2005
3. S.K.Duggal - Surveying Vol. I, Tata McGraw Hill Ltd ,Reprint 2015.
7. S.K. Duggal - Surveying Vol. II, Tata McGraw Hill Ltd ,Reprint 2015
4. Burrough P , Principles of Geographical Information systems, Oxford University Press, 1998
5. Iliffe, C.J., Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, 2006
6. James M Andersen, Edward M Mikhail, Surveying Theory and Practice, McGraw Hill education, 7e, 1998
7. Kang-tsung Chang, „Introduction to GIS" , Tata McGraw-Hill Publishing Co. Ltd, 8e, 2016
8. Lillesand M and Kiefer W, "Remote Sensing and Image Interpretation". John Wiley and Sons,Inc., 2000

Course Content and lecture Schedule:

No.	Topic	Course Outcome	No. of Hrs
1	**Module 1**		Total: 9
1.1	**Introduction to Surveying**- Principles, Linear, angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines,Local attraction, Declination, Methods of orientation	CO1	4
1.2	**Levelling**: Principles of levelling- Dumpy level, booking and reducing levels, Methods- simple, differential, reciprocal leveling, profile levelling and cross sectioning. Digital and Auto Level, Errors in leveling	CO1	4
1.3	**Contouring**: Characteristics, methods, uses.	CO1	1
2	**Module 2**		Total: 9
2.1	**Area and Volume**: computation of area by offsets to base line, by dividing area into number of triangles; volume of level section by prismoidal and trapezoidal formulae.	CO1	3
2.2	**Mass diagram**: Construction, Characteristics and uses	CO1	1
2.3	**Theodolite survey**: Instruments, Measurement of horizontal and vertical angle, principles of stadia and tangential tacheometry (introduction only)	CO2	2
2.4	**Triangulation:** Triangulation figures, Triangulation stations, Inter visibility of stations, Satellite Stations and reduction to centre.	CO2	3
3	**Module 3**		Total: 9
3.1	**Traverse Surveying** - Methods of traversing, Checks in closed traverse, Traverse computations, Balancing the traverse- Bowditch's rule, Transit rule, graphical method based on Bowditch's rule, Gales Traverse table, omitted measurements (a line and an angle only)	CO3	5
3.2	**Theory of Errors** – Types, theory of least squares, Weighting of observations, Most probable value, Computation of indirectly observed quantities - method of normal equations.	CO4	4
4	**Module 4**		Total: 9
4.1	C**urve Surveying** – Elements of simple and compound curves – Methods of setting out (Angular methods only)– Elements of Reverse curve (Introduction only)– Transition curve – length of curve – Elements of transition curve - Vertical curve (introduction only)	CO5	6
4.2	**Total Station** – concept of EDM, principles and working, advantages and applications	CO6	3
5	**Module 5**		Total: 9
5.1	**Global Positioning Systems**-Components and Principles, Satellite ranging-calculating position, signal structure,	CO6	3

	application of GPS, GPS Surveying methods-Static, Rapid static , Kinematic methods – DGPS		
5.2	**Remote Sensing** : Definition- Electromagnetic spectrum- Energy interactions with atmosphere and earth surface features- spectral reflectance of vegetation, soil and water- Classification of sensors- Active and Passive, Resolution-spatial, spectral radiometric and Temporal resolution, Multi spectral scanning- Along track and across track scanning	CO6	3
5.3	**Geographical Information System**-components of GIS, GIS operations, Map projections- methods, Coordinate systems- Geographic and Projected coordinate systems, Data Types- Spatial and attribute data, Raster and vector data representation	CO6	3

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

Course Code:**CET 205**

Course Name: **SURVEYING & GEOMATICS**
Model Question Paper

Marks:100 Duration: 3 hrs

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

1. What are the general principles of surveying?
2. Define back sight, foresight and intermediate sight.
3. How do you determine the intervisibilty of triangulation stations?
4. What is the principle of stadia tacheometry?
5. How will you determine probable error of computed quantities?
6. What are the checks in closed traverse?
7. What are the elements of a compound curve?
8. Explain the two theodolite method of setting out of simple curve.
9. What is multi spectral scanning? Differentiate along track and across track scanning.
10. What is meant by satellite ranging?

PART B
(Answer one full question from each module)

11. a. Define contour. What are the characteristics of contour? (4)

b. The following readings were taken in a running closed compass traverse.
Line FB BB
AB 49 °55’ 230 °00’
BC 177 °45’ 356 °00’
CD 104 °15’ 284 °55’
DE 165 °15’ 345 °15’
EA 259 °30’ 79 °90’
i) State the stations which were affected by local attraction.
ii) Determine the corrected bearings
iii) Calculate the true bearings if the declination was 1° 30’ W. (10)

OR

12. a. What are the different methods of orientation in plane table surveying? (4)

b. The following readings were taken with a dumpy level and a 4 m levelling staff on a continuously sloping ground at 30m intervals. 0.685, 1.455, 1.850, 2.330, 2.885 ,3.380, 1.055, 1.860, 2.265, 3.540, 0.835, 0.945, 1.530 and 2.250. The reduced level of the first point is 80.750. Rule out a page of a level book and enter the above readings. Determine RLs of all points using height of instrument method. Determine the gradient of the line joining the first and last point. (10)

13. a. The following perpendicular offsets were taken at 10m intervals from a survey line AB to an irregular boundary line: 2.50, 3.80, 4.33, 6.76, 5.30, 7.25, 8.95, 8.25 and 5.50.Calculate the area in sqm, enclosed between the survey line, the irregular boundary ,the first and the last offsets by i) Simpsons rule ii) Trapezoidal rule. (10)

b. Explain Mass diagram and its characteristics features. (4)

OR

14. a. Explain the method of observing the horizontal angle by the method of repetition and reiteration in triangulation survey. (4)

b. What is meant by satellite station and reduction to centre. From an eccentric station S, 13 metres to the west of the main station B, the following angles were measured. Angle BSC= 75°25'32", Angle CSA = 55°32'20''. The stations S and C are to the opposite sides of the line AB. Calculate the correct angle ABC if the lengths AB and BC are 5288m and 4940m respectively. (10)

15. a. The following are the mean values observed in the measurement of three angles
A, B, C at one station
A =86°42'46.2'' with weight 4
A+B =134°36°33.6'' with weight 3
A+B+C =262°18'10.4'' with weight 1
B+C =185°35'24.8'' with weight 2
Calculate the most probable value of A, B and C. (10)

b. Distinguish between a) closed traverse and open traverse b) loose needle method and fast needle method of traverse surveying (4)

OR

16. a. State the fundamental principle of method of least squares. How is the most probable value in direct observations of equal weights determined? (7)

b. Describe the procedures for balancing a closed traverse by graphical method. (7)

17. a. Two tangents intersect at chainage 1000 m, the deflection angle being $60^0$20'. Calculate the necessary data for setting out a curve of 200 m radius to connect two tangents if it is intended to set out the curve by Rankine's method of tangential angles. Take peg interval equal to 20 m. (10)

b. What are the advantages and applications of Total Station survey?(4)

OR

18. a. What is transition curve? What are its functions? What are the methods to find out the length of transition curve? (10)

19. b. Explain the principle behind electro magnetic distance measurement. (4)

20. a. What are the components of GPS? Illustrate with figure. Explain the functions of each of them in detail. (10)

b. What are the applications of GIS? (4)

OR

21. a. How does electro magnetic radiation interact with atmosphere? (7)

b. What are the various types of map projections based on the projection surface? (7)

CEL 201	CIVIL ENGINEERING PLANNING &DRAFTING LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2019

Preamble: The course is designed tointroduce the fundamentals of Civil Engineering drawingand understand the principles of planning. The students will be able to learn the drafting of buildings manually and using drafting software such as AutoCAD.

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Prerequisite:ENGINEERING GRAPHICS

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

Course Outcome (CO)	Course Outcome Description	CO assessment strategy
CO 1	Illustrate ability to organise civil engineering drawings systematically and professionally	Assessment of the overall organisation of the drawing, labels and templates used.
CO 2	Prepare building drawings as per the specified guidelines.	Application of guidelines for functional planning of building unit.
CO3	Assess a complete building drawing to include all necessary information	Level of incorporation of Guidelines specified by NBC, meeting the requirement of building rules specified by local bodies of administration.
CO 4	Create a digital formof the building plan using any drafting software	Evaluation of the printouts of prepared building plan

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	3	-	-	-	-	-	-	2	3	3	-	-
CO 2	3	-	-	-	-	-	-	2	3	3	-	-
CO 3	3	-	-	-	-	-	-	2	3	3	-	-
CO 4	3	-	-	-	-	-	-	2	2	3	-	-

List of Experiments (Any 12 experiments out of 15 need to be performed mandatorily.Manual drafting and drafting using computer aided drafting software is mandatory for the experiments)

1. Draw sectional details and elevation of paneled doors
2. Draw sectional details and elevation of glazedwindows and ventilators in wood.
3. Draw sectional details , detailing on fixing arrangement and elevation of steel windows.
4. Draw elevation, section and detailing of connection between members, arrangement for fixingat thesupport for steel roof truss.
5. Draw plan, section and elevation of dog legged staircase.
6. Draw sectional details of a load bearing wall over strip footing, RCC Column over isolated footing and pile footing with pile cap.
7. Draw plan, section and elevation of single storied residential buildings with flat roof.
8. Draw plan, section and elevation of two storied residential building.
9. Draw plan , section and elevation of a community hallhavingcorrugated GI sheetroof.
10. Prepare a site plan and service planas per latest buildingrules (KPBR or KMBR)
11. Prepare detailed drawing on building services (for single and two storied buildings only)and on-site wastewater disposal systems like septic tank and soak pit.
12. Draw plan, section and elevation of multi-storied framed buildings.
13. Draw plan, section and elevation of a public buildings–office complex, public health centre, post office, bank etc
14. Draw plan, section and elevation of a industrial building withcorrugated GI steel roof and PEB based walling elements.
15. Create 3D model of a two storied residential building and render the model.

References

1. National Building Code of India
2. Kerala panchayat building rules, 2019
3. Kerala Municipality building rules, 2019
4. Dr. Balagopal T.S. Prabhu, Building Drawing and Detailing, Spades Publishers, Calicut
5. AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, USA
6. Shah, M.G., Kale, C. M. and Patki, S.Y. Building Drawing With An Intergrated Approach to Built Environment, Tata McGraw Hill Publishing Company Limited, New Delhi

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Marks for 12 exercises using manual draftingin A4 Paper :**50 marks**

Marks for 12 exercises using computer aided drafting software in A3/A4 paper**: 25 marks**

COs	Assessment Strategy	Marking Criteria	Marks
CO 1	Assessment of the overall organisation of the drawing, labels and templates used.	Marks to be awarded based on the initial preparations displayed in manual drawing	**10**
CO 2	Application of guidelines for functional planning of building unit.	Marks to be awarded based on the prepared plan of the building	**20**
CO 3	Level of incorporation of Guidelines specified by NBC, meeting the requirement of building rules specified by local bodies of administration.	Marks to be awarded based on the checklists of assessment for the prepared plan of the building	**20**
CO 4	Evaluation of the printouts of prepared building plan	Marks to be awarded based on the printout of the final plan of the building	**25**

End Semester Examination Pattern: ESE will be of **2.5 hours** duration on A2 size answer booklet and will be for 75 marks. (only manual drafting for ESE)

CEL 203	SURVEY LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble:
Objective of the course is to impart practical experience to students by exposing them to various techniques of field surveying. The course is designed to make student familiar with conventional and advanced surveying instruments.

Prerequisite: Nil

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

CO 1	Use conventional surveying tools such as chain/tape and compass for plotting and area determination.
CO 2	Apply levelling principles in field
CO 3	Solve triangulation problems using theodolite
CO 4	Employ total station for field surveying
CO 5	Demonstrate the use of distomat and handheld GPS

Mapping of course outcomes with program outcomes

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Plot the given area using chain/tape and compass and compute its area.

Course Outcome 2 (CO2): Determine the reduced levels of the given points in the filed with respect to the Bench Mark of RL=100.00

Course Outcome 3 (CO3): Find out the distance between two inaccessible points A and B. Baseline measurement is allowed.

Course Outcome 4 (CO4): Compute the area of a given plot using total station.

Course Outcome 5 (CO5): Explain the parts of a handheld GPS with neat sketch.

Assessment Pattern

Bloom's Category	Continuous Assessment	End Semester Examination (marks)
Remember	**10**	**15**
Understand	**10**	**15**
Apply	**40**	**40**
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE (Marks)	ESE (Marks)	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern

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

End Semester Examination (ESE) Pattern:

Practical examination shall include problems on leveling/theodolite and total station with equal mark distribution. 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.

Syllabus

List of Exercises/ Experiments:

1. Introduction to conventional surveying - 1 session
2. Levelling - 4sessions
3. Theodolite surveying - 5sessions
4. Total Station survey - 4sessions
5. Study of instruments - 1 session
   - Automatic level
   - digital level
   - Handheld GPS

Course Content and Practical Schedule (Any twelve experiments are mandatory):

Expt. No.	List of exercises/experiments	Course Outcome	No. of Hrs
1	**Introduction to conventional surveying** a. Chain surveying b. Compass surveying	CO1	3
	Levelling	CO2	
2	Simple leveling		3
3	Differential levelling		3
4	Fly levelling		3
5	Contouring		3
	Theodolite surveying	CO3	
6	Distance between accessible points (horizontal angle)		3
7	Distance between inaccessible points (horizontal angle)		3
8	Level difference between points (vertical angle)		3
9	Tangential tacheometry (vertical angle)		3
10	Height of building (vertical angle)		3
	Total station survey	CO4	
11	Heights and distances		3
12	Area computation		3
13	Contouring		3
14	Downloading		3
15	**Study of instruments** a. Automatic level b. Digital level c. Handheld GPS	CO5	3

Reference Books

1. Dr. B.C. Punmia , Ashok Kumar Jain &Arun Kumar Jain - Surveying , Laxmi publications (P) Ltd , 2005
2. C. Venkatramaiah, Textbook of Surveying, Universities Press (India) Private Limited 2011

3. Prof. T.P.Kenetkar&Prof.S.V.Kulkarni - Surveying and Levelling , Pune VidyarthiGriha Prakashan,2004
4. R.Agor - A Text book of Surveying and Levelling, Khanna Publishers, 2005
5. S.K.Duggal - Surveying Vol. I, Tata McGraw Hill Ltd ,Reprint 2015.
6. S.K. Duggal - Surveying Vol. II, Tata McGraw Hill Ltd ,Reprint 2015

SEMESTER -3

MINOR

CET281	BUILDING CONSTRUCTION AND STRUCTURAL SYSTEMS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	4	0	0	4	2019

Preamble:

This course provides the essential aspects of building construction such as components of buildings, materials of construction and structural systems to the students of other branches of Engineering.

Pre requisite: Nil

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

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	Explain the properties and testing methods of different materials used for building construction.	Understanding
CO2	Explain the construction details of different components of buildings.	Understanding
CO3	Explain construction practices such as prefabricated, cost effective and sustainable technologies	Understanding
CO4	Explain the details and behavior of structural systems and structural elements used in buildings.	Understanding

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

CO1 Explain the properties and testing methods of different materials used for building construction.

1. What is blended cement? What are its advantages?
2. Explain any one test performed on coarse aggregate.
3. Discuss the role of admixtures in concrete
4. Explain any one test performed in fresh concrete.
5. Explain any one test performed on hardened concrete.

CO2 Explain the construction details of different components of buildings.

1. What is a lintel? Why is it required?
2. Explain the different types of shallow foundations.
3. Explain the different types of deep foundations.
4. Explain the procedure adopted for laying marble flooring.

CO3 Explain construction practices such as prefabricated, cost effective and sustainable technologies

1. What is prefabrication? What are the advantages and disadvantages of prefabricated construction?
2. Explain the construction details of rat-trap bond masonry.
3. Explain the principles of filler slab.

CO4 Explain the details and behavior of structural systems and structural elements used in buildings.

1. What are the different forms of reinforcement used in columns? Explain the functions of each.
2. Distinguish between load bearing wall construction and moment resisting frame construction.
3. Sketch any two types of steel roof truss.
4. Sketch the reinforcement details of a simply supported beam.

SYLLABUS

Module -1

Cement – Types, Composition, manufacturing process, properties, tests. Aggregates – properties, tests. Mortar – types, properties, uses. Chemical admixtures – types, uses.

Module -2

Concrete – PCC, RCC. Properties of fresh concrete, Workability – tests. Properties of hardened concrete – tests for strength, Nominal mix and design mix.

Module - 3

Flooring and roofing materials, Lintels and arches, Types and construction details of doors, windows and ventilators. Finishing works, Timber products, Formwork

Module -4

Foundations – shallow and deep, Cost effective construction, Sustainable building technologies, Non destructive testing of concrete, Prefabricated construction.

Module -5

Structural elements - beams, columns and slabs. Principles of reinforced concrete, types of reinforcements, Reinforcement details of structural elements, Structural systems, Concrete floor systems.

Text Books

1. Punmia B. C, Building Construction, Laxmi Publications
2. Arora and Bindra, Building Construction, Dhanpath Rai and Sons.
3. Shetty M.S., Concrete Technology, S. Chand & company.

References

1. Madan Mehta, Walter Scarborough and Diane Armpriest, Building Construction – Principles, Materials and Systems, Pearson.
2. Daniel Schodek and Martin Bechthold, Structures, Pearson.
3. V. SankaraSubramaniyan, Construction Technology, Lakshmi Publications, Chennai.
4. S. S. Bhavikatti, Construction Technology, Chess Educational Publishers, Chennai.
5. Rangwala S C., Engineering Materials, Charotar Publishers.

6. P. C. Varghese, Building Materials, PHI Learning Pvt Ltd., Delhi.
7. Mehta and Monteiro, Concrete - Micro structure, Properties and Materials, McGraw Hill Professional.
8. Neville A. M. and Brooks J. J., Concrete Technology, Pearson Education.
9. R. Santhakumar, Concrete Technology, Oxford Publications.

Lecture Plan - Building Construction and Structural Systems

Module	*Topic*	*Course Outcomes addressed*	*No. of Lectures*
1	**Module I : Total lecture hours : 9**		
1.1	Cement – Types of cements, chemical composition. Blended cements	CO1	1
1.2	Manufacturing of cement	CO1	1
1.3	Properties and tests on cement, Hydration of cement	CO1	2
1.4	Aggregates – types, role of aggregates.	CO1	1
1.5	Properties of aggregates and tests. Grading requirements. Natural and synthetic aggregates	CO1	2
1.6	Mortar – types, Sand – properties, uses	CO1	1
1.7	Water quality for construction. Chemical admixtures – types and uses.	CO1	1
2	**Module II : Total lecture hours : 10**		
2.1	Concrete – PCC, RCC and Prestressed concrete (brief descriptions only)	CO1	1
2.2	Making of concrete – batching, mixing, transporting, placing, compacting, finishing and curing	CO1	2
2.3	Properties of fresh concrete – workability, segregation and bleeding.	CO1	1
2.4	Factors affecting workability and strength – tests on workability, demonstration of slump test.	CO1	2
2.5	Effects of aggregates on properties of concrete	CO1	1
2.6	Properties of hardened concrete – tests for strength of concrete in compression, tension and flexure.	CO1	2
2.7	Nominal mixes and design mixes, mix designations, ready mixed concrete	CO1	1
3	**Module III : Total lecture hours : 8**		
3.1	Flooring and roofing materials	CO2	1
3.2	Lintels and arches – types.	CO2	1
3.3	Doors, Windows and ventilators – types and construction	CO2	2

	details		
3.4	Finishing works. Paint – types	CO1	1
3.5	Timber – seasoning	CO1	1
3.6	Timber products – properties and uses of plywood, fibre board and particle board	CO1	1
3.7	Formwork, Construction and expansion joints	CO2	1
4	**Module IV : Total lecture hours : 10**		
4.1	Types of shallow foundations.	CO2	1
4.2	Types of deep foundations.	CO2	1
4.3	Foundation failure – causes	CO2	1
4.4	Introduction to cost effective construction – principles of filler slab and rat-trap bond masonry.	CO3	2
4.5	Sustainable building technologies.	CO3	2
4.6	Non destructive testing of concrete – rebound hammer test and ultrasonic pulse velocity test.(with demonstrations)	CO1	2
4.7	Introduction to prefabricated construction- advantages, slip form construction	CO3	1
5	**Module V : Total lecture hours : 8**		
5.1	Introduction to structural systems – functions, Primary structural elements – beams, columns and slabs.	CO4	1
5.2	Principles of reinforced concrete, types of reinforcements – tension reinforcements, compression reinforcements and stirrups.	CO4	2
5.3	Reinforcement details of beams, columns and slabs.	CO4	2
5.4	Structural systems – load bearing walls, moment resisting frames	CO4	1
5.5	Structural systems – trusses, cables and membranes	CO4	1
5.6	Elevated concrete floor systems, beams supported concrete floors – one way and two way slabs, flat slabs.	CO4	1

MODEL QUESTION PAPER

Reg.No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CET281

Course Name: BUILDING CONSTRUCTION AND STRUCTURAL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions; each question carries 3 marks.

1. a) What is hydration of cement?
   b) What is mortar? What are its uses?
   c) What are the advantages of prestressed concrete over conventional reinforced concrete?
   d) Distinguish between nominal mix and design mix.
   e) Name different types of paints and mention their use.
   f) List different types of timber products used in building construction.
   g) What is a raft foundation?
   h) Explain any one non destructive test used to assess the quality of concrete.
   i) What is a truss? How does a truss resist external loads?
   j) Why is reinforcement essential in concrete beams?

(10×3 marks = 30 marks)

PART B

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

Module I

2. a) What is mean by grading of aggregates? (5)
   b) Explain the process of manufacturing cement. (9)
3. a) Explain the role of admixtures in concrete (5)
   b) Explain the various tests used to assess properties of cement. (9)

Module II

4. a) What is curing of concrete? Why is it important? (5)
   b) What is meant by workability of concrete? Discuss the factors influencing workability of concrete. (9)
5. a) Distinguish between segregation and bleeding. (5)

	b)	Explain the various tests performed on hardened concrete.	(9)

Module III

6.	a)	Sketch a typical arch and mark its parts.	(5)
	b)	What is seasoning of timber? Explain different methods of seasoning.	(9)
7.	a)	What is a lintel? Why it is required?	(5)
	b)	Explain different types of scaffoldings.	(9)

Module IV

8.	a)	Explain with neat sketches any three types of foundations.	(6)
	b)	Describe the causes of foundation failure.	(8)
9.	a)	What is a slip form? Where are they used?	(6)
	b)	Explain the construction of filler slabs.	(8)

Module V

10.	a)	What are the functions of a structural system?	(5)
	b)	With the help of neat sketches, explain the different forms of reinforcement used in beams? Also explain the functions of each.	(9)
11.	a)	Distinguish between one way and two way slab systems.	(5)
	b)	Compare load bearing wall construction and moment resisting frame construction.	(9)

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CET 283	INTRODUCTION TO GEOTECHNICAL ENGINEERING	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 of soil mechanics and foundation engineering. 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 basic concepts, theories and methods of analysis in soil mechanics and foundation engineering
CO 2	Solve the basic properties of soil by applying functional relationships
CO 3	Determine the engineering properties of soil by applying the laboratory test results and the fundamental concepts
CO 4	Estimate the design parameters of footings and retaining walls

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation (CIE) Pattern :

Attendance : 10 Marks

Continuous Assessment Test (2 numbers) : 25 Marks

Assignment/Quiz/Course project : 15 Marks

End Semester 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, shear strength, consolidation & compaction
3. Concepts of Total, neutral and effective stress; and vertical stress below loaded areas
4. Basic theories of Earth pressure, Bearing Capacity and Settlement of footings

Course Outcome 2 (CO2):

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

Course Outcome 3 (CO3):

1. Calculate the engineering properties of soil related to Permeability, consolidation, compaction & shear strength by applying the laboratory test results
2. 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

Course Outcome 4 (CO4):

1. Estimate the earth pressure acting on the retaining walls
2. Estimate the bearing capacity of footings
3. Estimate the immediate and consolidation settlement of footings

Model Question Paper

QP CODE:

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CET 283

Course Name : INTRODUCTION TO GEOTECHNICAL ENGINEERING

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 different types of soil structures.
3. Define (i) Well graded, (ii) Poorly graded and (iii) Gap graded soils
4. Define (i) Liquid Limit, (ii) Plastic Limit and (iii) Shrinkage Limit
5. Explain Mohr Coulomb shear strength theory.
6. Explain different types of earth pressures.
7. Explain the situations in which combined footings are provided.
8. List the assumptions of Terzaghi's theory of bearing capacity.
9. Define (i) pre consolidation pressure, (ii) Compression Index and (iii) Recompression Index.
10. Differentiate between Consolidation and Compaction.

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 the procedures to determine the field density of soil. (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) 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)

14. (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. (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 $\gamma_w = 10$ kN/m^3. (9 Marks)

Module – 3

15. (a) List the advantages and disadvantages of Direct Shear Test. (7 Marks)

(b) 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. (7 Marks)

16. (a) Explain critical depth of an unsupported cut in a cohesive soil. (5 Marks)

(b) A retaining wall 8m high with a smooth vertical back retains a sandy backfill (ϕ =340 , Density of soil above water table is 18 kN/m3 and below water table is 19 kN/m3). Water table is at 3 m below ground level. Find the total active pressure per metre length of the wall and its point of application above the base by Rankine's theory. (9 Marks)

Module – 4

17. Explain different types of shallow foundations and list the advantages and disadvantages of each type of footings. (14 Marks)

18. (a) Explain various factors that affect ultimate bearing capacity of a shallow footing? (5 Marks)

(b) A square footing of 2 m x 2 m is to be founded at a depth of 1.5 m in a soil with following data:

γ = 19 kN/m^3 ; C = 30 kN/m^2 ; $\phi = 40^0$

N_c = 95.7 ; N_q = 81.3 ; N_γ = 100.4

Determine the net safe bearing capacity with a factor of safety of 3, when Water table is at
(i) 0.75 m from ground level. (ii) 2.5 m from ground level. (9 Marks)

Module – 5

19. (a) What is meant by Immediate Settlement? How to determine this. (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)

20. (a) What is meant by Allowable settlement? (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)

SYLLABUS

Module	Contents
1	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. Laboratory Determination of Water content by oven drying; Specific gravity using pycnometer & specific gravity bottle and Field density by sand replacement method – Field density by Core Cutter method - Soil Structure: single grained, honey combed, flocculated and dispersed structure and their effects on the basic soil properties – Sensitivity and Thixotropy.
2	Index properties - Sieve analysis – Well graded, poorly graded and gap graded soils - Consistency - Atterberg Limits and Plasticity Index – Plasticity Chart –I.S. classification. Permeability of soils - Darcy's law – Numerical Problems - Factors affecting permeability Principle of effective stress - Total, neutral and effective stress – Pressure diagrams - numerical problems Stress distribution - Boussinesq's equations for vertical pressure due to point loads – Approximate methods for Vertical Pressure beneath rectangular shape: 2:1 Distribution Method - numerical problems -Isobars- Pressure bulbs
3	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 [no derivation required] – Numerical Problems - Brief discussion of Direct shear test & UCC Lateral earth pressure – At-rest, active and passive earth pressures – Rankine's theories [no derivation required] - Influence of surcharge, layered backfill and water table on earth pressure- numerical problems
4	Foundation - general consideration : Functions of foundations - Definition of shallow and deep foundations - Different types of foundations : Strip Footings; Isolated Footings; Combined Footings – Rectangular and Trapezoidal; Raft Foundations and Pile Foundations - Selection of type of foundation - Advantages and limitations of various types of foundations Bearing capacity of shallow foundations – Ultimate, safe and allowable bearing capacity. - Failure mechanism, assumptions and equation of Terzaghi's bearing capacity theory for strip footing [no derivation required] – Bearing capacity factors and charts - Terzaghi's formulae for circular and square footings - numerical problems - Local and general shear failure - Factors affecting bearing capacity – Effect of water table on bearing capacity - numerical problems -
5	Settlement analysis: Introduction - causes of settlement – immediate, consolidation and total settlement –Estimation of immediate settlement – Numerical Problems – Consolidation - Definition – Spring analogy for primary consolidation - Void ratio versus pressure relationship - Coefficient of compressibility and volume compressibility – Pre consolidation Pressure - Compression index-Estimation of magnitude of settlement of normally consolidated clays - Numerical problems Allowable settlement - Total and differential settlements as per Indian standard Compaction of soils - Difference between consolidation and compaction - IS Light & Heavy Compaction Tests – OMC and MDD

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	1
1.4	Numerical problems	CO 2	2
1.5	Determination of Water content by oven drying, Specific gravity using pycnometer & specific gravity bottle	CO 1	1
1.6	Determination of Field density by sand replacement method & Core Cutter method	CO 1	1
1.7	Numerical problems	CO 2	1
1.8	Soil Structure and their effects on the basic soil properties – Sensitivity and Thixotropy	CO 1	1
2	**Module 2**		**9**
2.1	Index properties - Sieve analysis – Well graded, poorly graded and gap graded soils	CO 1	1
2.2	Consistency - Atterberg Limits and Plasticity Index	CO 1	1
2.3	Plasticity Chart –I.S. classification	CO 1	1
2.4	Permeability of soils - Darcy's law – Factors affecting permeability	CO 1	1
2.5	Principle of effective stress - Total, neutral and effective stress – Pressure diagrams	CO 1	1
2.6	Numerical problems	CO 3	1
2.7	Stress distribution - Introduction - Boussinesq's equations for vertical pressure due to point loads – Numerical problems	CO 1 & CO 3	1
2.8	Approximate methods for Vertical Pressure beneath rectangular shape: 2:1 Distribution Method - numerical problems	CO 1 & CO 3	1
2.9	Isobars- Pressure bulbs	CO 4	1
3	**Module 3**		**9**
3.1	Shear strength of soils- Practical Applications - Mohr-Coulomb failure criterion	CO 1	1
3.2	Mohr circle method for determination of principal planes and stresses– relationship between shear parameters and principal stresses [no derivation required]	CO 1	1
3.3	Numerical Problems	CO 3	
3.4	Brief discussion of Direct shear test & UCC	CO 1	1

3.5	Lateral earth pressure – At-rest, active and passive earth pressure	CO 1	1
3.6	Rankine's theories [no derivation required]	CO 1	1
3.7	Influence of surcharge and water table on earth pressure	CO 1	1
3.8	Numerical problems	CO 4	1
3.9	Earth pressure on retaining walls with layered backfill – Numerical Problems	CO 1 & CO 4	1
4	**Module 4**		**9**
4.1	Foundations : Functions of foundations - Definition of shallow and deep foundations	CO 1	1
4.2	Different types of foundations : Strip Footings; Isolated Footings; Combined Footings – Rectangular & Trapezoidal; Raft Foundations and Pile Foundations	CO 1	1
4.3	Selection of type of foundation - Advantages and limitations of various types of foundations	CO 1	1
4.4	Bearing capacity of shallow foundations – Ultimate, safe and allowable bearing capacity.	CO 1	1
4.5	Failure mechanism, assumptions and equation of Terzaghi's bearing capacity theory for strip footing [no derivation required]	CO 1	1
4.6	Bearing capacity factors and charts - Terzaghi's formulae for circular and square footings -	CO 1	1
4.7	Numerical problems	CO 4	1
4.8	Effect of water table on bearing capacity - numerical problems	CO 1 & CO 4	1
4.9	Local and general shear failure - Factors affecting bearing capacity	CO 1	1
5	**Module 5**		**9**
5.1	Settlement analysis: Introduction - causes of settlement – immediate, consolidation and total settlement	CO 1	1
5.2	Estimation of immediate settlement – Numerical Problems	CO 1 & CO 4	1
5.3	Consolidation - Definition – Spring analogy for primary consolidation	CO 1	1
5.4	Void ratio versus pressure relationship - Coefficient of compressibility and volume compressibility – Pre consolidation Pressure - Compression index	CO 1	1
5.5	Estimation of magnitude of settlement of normally consolidated clays - Numerical problems	CO 4	1
5.6	Allowable settlement - Total and differential settlements as per Indian standard	CO 1	1
5.7	Compaction of soils - Difference between consolidation and compaction	CO 1	1
5.8	IS Light & Heavy Compaction Tests – OMC and MDD	CO 1	1
5.9	Numerical Problems	CO 3	1

CODE: CET 285	Course Name INFORMATICS FOR INFRASTRUCTURE MANAGEMENT	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

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

Prerequisite: NIL

Course Outcomes:

Course Outcome	Description of Course Outcome	Prescribed learning level
CO 1	To understand the fundamental concepts of data science, informatics & internet of things	Remembering, Understanding
CO 2	To learn the use of geomaticsin planning and site selection of infrastructure projects	Applying & Analysing
CO 3	To apply building informatics in construction, monitoring and project management	Applying& Analysing
CO4	To learn the role of IoT technology in infrastructure management	Applying& Analysing

Mapping of course outcomes with program outcomes (Minimum requirement)

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

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

Course Outcome 1 (CO1):*To understand the fundamental concepts of data science, informatics & internet of things.*

1. ExplainDIKW pyramid.
2. Explain the data mining techniques
3. Discuss different data models
4. Discuss the vector data analysis techniques
5. Explain COBie standard
6. List IoT protocols
7. What are the elements of BIM?

Course Outcome 2 (CO2): *To learn the use of geomatics for planning and site selection of infrastructure projects.*

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

Course Outcome 3 (CO3): *To apply building informatics in construction, monitoring and project management.*

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

Course Outcome 4 (CO4): *To learn the role of IoT technology in infrastructure management.*

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

Syllabus

Module 1 Data to Information

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

Module 2 Geoinformatics

Fundamental concepts in Geo-informatics- Components, Spatial data and attributes, vector and raster data models, Methods of data input, Spatial data editing; Vector data analysis- buffering, overlay; Raster data analysis- local operations, neighborhood operations, zonal operations ; GIS output: cartographic and non-cartographic output

Module 3 Planning and Site selection

Site suitability analysis for Residential area, Industrial area, Recreational Area, Solid Waste Disposal, Water treatment plant, reservoirs;
Land use/ Land cover mapping, Ground Water Potential Zonation Mapping, Hazard Zonation Mapping, Terrain modelling
Network Analysis- Water supply line, Sewer line, Power line, Telecommunication, Road network

Module 4 Building Informatics

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

Module 5 Internet of Things (IoT) in Civil Infrastructure

IoT Standards& Protocols, Concept of IoT in civil engineering- Applications in construction, product monitoring and project Management
Smart Buildings- sensors & devices, selection criteria, data integration
Management Applications- Traffic Regulation, Water Supply, Pollution control, HVAC, Energy use

Text Books

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

Reference Books

1. Raja R. A. Issa and Svetlana Olbina,Building Information Modeling: Applications and Practices, ASCE, 2015.

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

Lecture Plan – Informatics for Infrastructure Management

Module	*Topic*	*Course outcomes addressed*	*No. of Lectures*
1	**Module I : Total lecture hours : 9**		
1.1	History of informatics	CO1	Lecture 1
1.2	DIKW pyramid& Meta data	CO1	Lecture 2
1.3	Data management	CO1	Lecture 3
1.4	Data types & Meta data	CO1	Lecture 4
1.5	Database management systems	CO1	Lecture 5
1.6	Data analysis techniques	CO1	Lecture 6
1.7	Trends & Patterns in data analysis	CO1	Lecture 7
1.8	Data mining techniques	CO1	Lecture 8
1.9	Data processing for information	CO1	Lecture 9
2	**Module II : Total lecture hours : 9**		
2.1	Fundamental concepts in Geo-informatics-	CO1	Lecture 1
2.2	Components of GIS	CO1	Lecture 2
2.3	Spatial data and attributes	CO1	Lecture 3
2.4	Data models- vector & raster	CO1	Lecture 4
2.5	Methods of data input	CO1	Lecture 5
2.6	Spatial data editing	CO1	Lecture 6
2.7	Vector data analysis	CO1	Lecture 7
2.8	Raster data analysis- local & neighbourhood analysis	CO1	Lecture 8
2.9	Raster data analysis- zonal analysis& GIS output	CO1	Lecture 9

3	**Module III : Total lecture hours : 9**		
3.1	Site suitability analysis for Residential area,& Industrial area	CO2	Lecture 1
3.2	Site suitability analysis for recreational area & solid waste disposal	CO2	Lecture 2
3.3	Site suitability analysis for water treatment plant & reservoir	CO2	Lecture 3
3.4	Land use&land cover mapping	CO2	Lecture 4
3.5	Ground water potential zonation& Hazard zonation mapping	CO2	Lecture 5
3.6	Terrain modelling	CO2	Lecture 6
3.7	Network analysis for water supply & sewer lines	CO2	Lecture 7
3.8	Network analysis for power line & telecommunication	CO2	Lecture 8
3.9	Network analysis for road network	CO2	Lecture 9
4	**Module IV : Total lecture hours : 9**		
4.1	Building Information Modelling- Definition	CO3	Lecture 1
4.2	Elements of BIM	CO3	Lecture 2& 3
4.3	Steps in BIM development	CO3	Lecture 4 & 5
4.4	COBie standard	CO3	Lecture 6
4.5	Potential & applications of BIM	CO3	Lecture 7
4.6	Case studies of BIM	CO3	Lecture 8& 9
5	**Module V : Total lecture hours : 9**		
5.1	IoT Standards & Protocols, Concept of IoT in civil engineering	CO4	Lecture 1
5.2	Application of IoT in construction, product monitoring & project management	CO4	Lecture 2,3 & 4
5.3	Smart buildings	CO4	Lecture 5
5.5	Selection criteria of sensors & devices, Data integration	CO4	Lecture 6
5.7	Management applications of IoT- Traffic, water supply, pollution control, HVAC & energy use	CO4	Lecture7,8 & 9

Model Question Paper

QP CODE:

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

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code:CET 285

Course Name: INFORMATICS FOR INFRASTRUCTURE MANAGEMENT

Max. Marks: 100 Duration: 3 hours

Part A

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

1. Explain different data types.
2. Explain DIKW pyramid.
3. Compare vector & raster model.
4. What are the components of GIS?
5. Explain network analysis.
6. What is the importance of terrain modeling?
7. Define BIM.
8. What is COBie standard?
9. List the IoT protocols.
10. Explain the concept of smart buildings.

PART B

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

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

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

OR

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

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

13. (a) Discuss various data inputting methods for GIS (5 Marks)

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

OR

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

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

15. (a) How the site suitability analysis is carried out for a solid waste management facility? (7 Marks)

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

OR

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

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

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

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

OR

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

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

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

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

OR

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

(b) Discuss how IoT technologies could help in pollution control. (7 Marks)

SEMESTER -3

MATHEMATICS – Third Semester B. Tech

(For all branches except Computer Science and Information Technology)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT201	PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS	BASIC SCIENCE COURSE	3	1	0	4

Preamble: This course introduces basic ideas of partial differential equations which are widely used in the modelling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. To understand the basic theory of functions of a complex variable, residue integration and conformal transformation.

Prerequisite: A basic course in partial differentiation and complex numbers**.**

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

CO 1	Understand the concept and the solution of partial differential equation.
CO 2	Analyse and solve one dimensional wave equation and heat equation.
CO 3	Understand complex functions, its continuity differentiability with the use of Cauchy-Riemann equations.
CO 4	Evaluate complex integrals using Cauchy's integral theorem and Cauchy's integral formula, understand the series expansion of analytic function
CO 5	Understand the series expansion of complex function about a singularity and Apply residue theorem to compute several kinds of real integrals.

Mapping of course outcomes with program outcomes

PO's	Broad area
PO 1	Engineering Knowledge
PO 2	Problem Analysis
PO 3	Design/Development of solutions
PO 4	Conduct investigations of complex problems
PO 5	Modern tool usage
PO 6	The Engineer and Society
PO 7	Environment and Sustainability
PO 8	Ethics
PO 9	Individual and team work

PO 10	Communication
PO 11	Project Management and Finance
PO 12	Life long learning

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(%)		End Semester Examination(%)
	1	2	
Remember	10	10	10
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	10	10	10
Create			

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

Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. Form the partial differential equation given $z = xf(x) + ye^2$
2. What is the difference between complete integral and singular integral of a partial differential equation
3. Solve $3z = xp + yq$
4. Solve $(p^2 + q^2)y = qz$
5. Solve $u_x - 2u_t = u$ by the method of separation of variables

Course Outcome 2 (CO2):

1. Write any three assumptions in deriving one dimensional wave equations
2. Derive one Dimensional heat equation
3. Obtain a general solution for the one dimensional heat equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial t^2}$
4. A tightly stretched flexible string has it's ends fixed at $x = 0$and $x = l$. At $t = 0$, the string is given a shape defined by $f(x) = \mu x(l - x)$ where μ is a constant
5. Find the temperature $u(x, t)$ in a bar which is perfectly insulated laterally whose ends are kept at $0°C$ and whose initial temperature (in degree Celsius) is $f(x) = x(10 - x)$ given that it's length is 10 cm and specific heat is 0.056cal/gram deg

Course Outcome 3(CO3):

1. Separate the real and imaginary parts of $f(z) = \frac{1}{1+z}$
2. Check whether the function $f(z) = \frac{Re(z^2)}{|z|}$ is continuous at $z = 0$ given $f(0) = 0$
3. Determine a and b so that function $u = e^{-\pi x} cosay$ is harmonic. Find it's harmonic conjugate.
4. Find the fixed points of $w = \frac{i}{2z-1}$
5. Find the image of $|z| \leq \frac{1}{2}$, $-\frac{\pi}{8} < argz < \frac{\pi}{8}$under $w = z^2$

Course Outcome 4(CO4):

1. Find the value of $\int_C exp(z^2)dz$ where C is $|z| = 1$
2. Integrate the function $\int_C \frac{sinz}{z+4iz} dz$ where C is $|z - 4 - 2i| = 6.5$
3. Evaluate $\int_C \frac{e^z}{\left(z-\frac{\pi}{4}\right)^3} dz$ where C is $|z| = 1$
4. Find the Maclaurin series expansion of $f(z) = \frac{i}{1-z}$ and state the region of convergence.
5. Find the image of $|z| = 2$ under the mapping $w = z + \frac{1}{z}$

Course Outcome 5 (CO5):

1. Determine the singularity of $exp\left(\frac{1}{z}\right)$
2. Find the Laurent series of $\frac{1}{z^2(z-i)}$ about $z = i$
3. Find the residues of $f(z) = \frac{50z}{z^3 + 2z^2 - 7z + 4}$
4. Evaluate $\int_C tan2\pi z \, dz$ where C is $|z - 0.2| = 0.2$
5. Evaluate $\int_0^{2\pi} \frac{d\theta}{\sqrt{2} - cos\,\theta}$

Syllabus

Module 1 (Partial Differential Equations) (8 hours)

(Text 1-Relevant portions of sections 17.1, 17.2, 17.3, 17.4, 17.5, 17.7, 18.1, 18.2)

Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order-Lagrange's linear equation, Non-linear equations of the first order -Charpit's method, Solution of equation by method of separation of variables.

Module 2 (Applications of Partial Differential Equations) (10 hours)

(Text 1-Relevant portions of sections 18.3,18.4, 18.5)

One dimensional wave equation- vibrations of a stretched string, derivation, solution of the wave equation using method of separation of variables, D'Alembert's solution of the wave equation, One dimensional heat equation, derivation, solution of the heat equation

Module 3 (Complex Variable – Differentiation) (9 hours)

(Text 2: Relevant portions of sections13.3, 13.4, 17.1, 17.2 , 17.4)

Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugate, Conformal mappings- mappings $w = z^2,, w = e^z,$. Linear fractional transformation $w = \frac{1}{z}$, fixed points, Transformation $w = sinz$

(From sections 17.1, 17.2 and 17.4 only mappings $w = z^2,, w = e^z, w = \frac{1}{z}$, $w = sinz$ and problems based on these transformation need to be discussed)

Module 4 (Complex Variable – Integration) (9 hours)

(Text 2- Relevant topics from sections14.1, 14.2, 14.3, 14.4,15.4**)**

Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method-indefinite integration and substitution of limit, second evaluation method-use of a representation of a path, Contour integrals, Cauchy integral theorem (without proof) on simply connected domain,Cauchy integral theorem (without proof) on multiply connected domain Cauchy Integral formula (without proof), Cauchy Integral formula for derivatives of an analytic function, Taylor's series and Maclaurin series.,

Module 5 (Complex Variable – Residue Integration) (**9 hours**)

(Text 2- Relevant topics from sections16.1, 16.2, 16.3, 16.4 **)**

Laurent's series(without proof), zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem, Residue integration of real integrals – integrals of rational functions of $cos\theta$ and $sin\theta$, integrals of improper integrals of the form

$\int_{-\infty}^{\infty} f(x)\,dx$ with no poles on the real axis. ($\int_{A}^{B} f(x)\,dx$ whose integrand become infinite at a point in the interval of integration is excluded from the syllabus),

Textbooks:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.

2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

References:

1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012

Assignments

Assignment: Assignment must include applications of the above theory in the concerned engineering branches

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Partial Differential Equations**	
1.1	Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration,	3
1.2	Linear equations of the first order- Lagrange's linear equation, Non-linear equations of the first order - Charpit's method	3
1.3	Boundary value problems, Method of separation of variables.	2
2	**Applications of Partial Differential Equations**	
2.1	One dimensional wave equation- vibrations of a stretched string, derivation,	1
2.2	Solution of wave equation using method of separation of variables, Fourier series solution of boundary value problems involving wave equation, D'Alembert's solution of the wave equation	4
2.3	One dimensional heat equation, derivation,	1
2.4	Solution of the heat equation, using method of separation of variables, Fourier series solutions of boundary value problems involving heat equation	4

3	**Complex Variable – Differentiation**	
3.1	Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations,	4
3.2	harmonic functions, finding harmonic conjugate,	2
3.3	Conformal mappings- mappingsof $w = z^2, , w = e^z, w = \frac{1}{z}, w = sinz$.	3
4	**Complex Variable – Integration**	
4.1	Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method, second evaluation method, use of representation of a path	4
4.2	Contour integrals, Cauchy integral theorem (**without proof**) on simply connected domain, on multiply connected domain(**without proof**) .Cauchy Integral formula (**without proof**),	2
4.3	Cauchy Integral formula for derivatives of an analytic function,	2
4.3	Taylor's series and Maclaurin series.	1
5	**Complex Variable – Residue Integration**	
5.1	Laurent's series(**without proof**)	2
5.2	zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues,	2
5.3	Cauchy Residue theorem (**without proof**), Evaluation of definite integral using residue theorem	2
5.4	Residue integration of real integrals – integrals of rational functions of $cos\theta$and $sin\theta$, integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x)dx$with no poles on the real axis. ($\int_A^B f(x)dx$**whose integrand become infinite at a point in the interval of integration is excluded from the syllabus**),	3

Model Question Paper

(For all branches except Computer Science and Information Technology)

(2019 Scheme)

Reg No: Name:

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH. DEGREE EXAMINATION

(MONTH & YEAR)

Course Code:

Course Name: PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS

MAX.MARKS: 100 DURATION: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1. Derive a partial differential equation from the relation $z = f(x + at) + g(x - at)$
2. Solve $\frac{\partial^2 z}{\partial x \partial y} = x^2 y$
3. State any three assumptions in deriving the one dimensional wave equation
4. What are the possible solutions of one-dimensional heat equation?
5. If $f(z) = u + iv$ is analytic, then show that u *and* v are harmonic functions.
6. Check whether $f(z) = \bar{z}$ is analytic or not.
7. Evaluate $\int_c tan\, z\, dz$ where c is the unit circle.
8. Find the Taylor's series of $f(z) = \frac{1}{z}$ about $z = 2$.
9. What type of singularity have the function $f(z) = \frac{1}{\cos z - \sin z}$
10. Find the residue of $\frac{e^z}{z^3}$ at its pole.

PART B

Answer any one full question from each module, each question carries 14 marks.

Module-I

11. (a) Solve $x(y - z)p + y(z - x)q = z(x - y)$
    (b) Use Charpit's methods to solve $q + xp = p^2$
12. (a) Find the differential equation of all spheres of fixed radius having their centers in the xy-plane.

(b) Using the method of separation of variables, solve $\frac{\partial u}{\partial x} = 2\frac{\partial u}{\partial t} + u$, where $u(x,0) = 6e^{-3x}$.

Module – II

13. (a) Derive the solution of one dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ with zero boundary conditions and with initial conditions $u(x,0) = f(x)$ and $\left(\frac{\partial u}{\partial t}\right)_{t=0} = 0$.

(b) A homogeneous rod of conducting material of length 100 cm has its ends kept at zero temperature and the temperature initially is $u(x,0) = \begin{cases} x, 0 \le x \le 50 \\ 100 - x, 50 \le x \le 100 \end{cases}$. Find the temperature $u(x,t)$ at any time.

14. (a) A tightly stretched string of length l with fixed ends is initially in equilibrium position. It is set vibrating by giving each point a velocity $v_0 \sin^3\left(\pi x/l\right)$. Find the displacement of the string at any time.

(b) An insulated rod of length l has its ends A and B are maintained at $0^0 c$ and $100^0 C$ respectively under steady state condition prevails. If the temperature at B is suddenly reduced to $0^0 c$ and maintained at $0^0 c$, Find the temperature at a distance *x* from A at time t.

Module-III

15. (a) Show that $f(z) = e^z$ is analytic for all z. Find its derivative.

(b) Find the image of $|z - 2i| = 2$ under the transformation $w = \frac{1}{z}$

16. (a) Prove that the function $u(x,y) = x^3 - 3xy^2 - 5y$ is harmonic everywhere. Find its harmonic conjugate.

(b) Find the image of the infinite stripe $0 \le y \le \pi$ under the transformation $w = e^z$

Module-IV

17. (a) Evaluate $\int_0^{2+i} (\bar{z})^2 \, dz$, along the real axis to 2 and then vertically to $2 + i$

(b) Using Cauchy's integral formula evaluate $\int_c \frac{5z+7}{z^2+2z-3} dz$, where c is $|z - 2| = 2$

18. (a) Evaluate $\int_c \frac{\sin^2 z}{\left(z - \frac{\pi}{6}\right)^3} dz$, where C is $|z| = 1$.

(b) Expand $\frac{1}{(z-1)(z-2)}$ in the region $|z| < 1$

Module- V

19. (a) Expand $f(z) = \frac{z^2-1}{z^2-5z+6}$ in $2 < |z| < 3$ as a Laurent's series.

(b) Using contour integration evaluate $\int_0^{2\pi} \frac{d\theta}{2+\cos\theta}$

20. (a) Use residue theorem to evaluate $\int_c \frac{\cos h\, \pi z}{z^2+4} dz$ where are C is $|z| = 3$.

(b) Apply calculus of residues to evaluate $\int_{-\infty}^{\infty} \frac{1}{(x^2+1)^3} dx$.

DISCRETE MATHEMATICAL STRUCTURES

MAT 203	DISCRETE MATHEMATICAL STRUCTURES	CATEGORY	L	T	P	CREDITS
		BSC	3	1	0	4

Preamble:

The purpose of this course is to create awareness in students about the basic terminologies used in advanced courses in Computer Science and develop rigorous logical thinking for solving different kinds of problems in Computer Science. This course helps the learner to apply the theory and applications of elementary Counting Principles, Propositional Logic, Predicate Logic, Lattices, Generating Functions, Recurrence Relations and Algebraic Structures eventually in practical applications.

Prerequisite: A sound background in higher secondary school Mathematics

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

CO#	CO
CO1	Check the validity of predicates in Propositional and Quantified Propositional Logic using truth tables, deductive reasoning and inference theory on Propositional Logic **(Cognitive Knowledge Level: Apply)**
CO2	Solve counting problems by applying the elementary counting techniques - Rule of Sum, Rule of Product, Permutation, Combination, Binomial Theorem, Pigeonhole Principle and Principle of Inclusion and Exclusion **(Cognitive Knowledge Level: Apply)**
CO3	Classify binary relations into various types and illustrate an application for each type of binary relation, in Computer Science (**Cognitive Knowledge Level: Understand)**
CO4	Illustrate an application for Partially Ordered Sets and Complete Lattices, in Computer Science **(Cognitive Knowledge Level: Apply)**
CO5	Explain Generating Functions and solve First Order and Second Order Linear Recurrence Relations with Constant Coefficients **(Cognitive Knowledge Level: Apply)**
CO6	Illustrate the abstract algebraic systems - Semigroups, Monoids, Groups, Homomorphism and Isomorphism of Monoids and Groups **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of Series Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Syllabus

Module – 1 (Fundamentals of Logic)

Mathematical logic - Basic connectives and truth table, Statements, Logical Connectives, Tautology, Contradiction. Logical Equivalence - The Laws of Logic, The Principle of duality, Substitution Rules . The implication - The Contrapositive, The Converse,The Inverse.

Logical Implication - Rules of Inference. The use of Quantifiers - Open Statement, Quantifier. Logically Equivalent – Contrapositive, Converse , Inverse , Logical equivalences and implications for quantified statement, Implications , Negation .

Module - 2 (Fundamentals of Counting Theory)

The Rule of Sum – Extension of Sum Rule . The Rule of Product - Extension of Product Rule . Permutations. Combinations. The Binomial Theorem (without proof). Combination with Repetition. The Pigeon hole Principle. The Principle of Inclusion and Exclusion Theorem (Without Proof) - Generalization of the Principle. Derangements.

Module - 3 (Relations and Functions)

Cartesian Product - Binary Relation. Function – domain , range-one to one function, Image-restriction. Properties of Relations- Reachability Relations, Reflexive Relations, Symmetric Relations, Transitive relations, Anti-symmetric Relations, Partial Order relations, Equivalence Relations, Irreflexive relations.

Partially ordered Set – Hasse Diagram, Maximal-Minimal Element, Least upper bound (lub), Greatest Lower bound(glb) (Topological sorting Algorithm- excluded). Equivalence Relations and Partitions - Equivalence Class.

Lattice - Dual Lattice , Sub lattice , Properties of glb and lub , Properties of Lattice , Special Lattice , Complete Lattice, Bounded Lattice, Completed Lattice , Distributive Lattice.

Module - 4 (Generating Functions and Recurrence Relations)

Generating Function - Definition and Examples , Calculation techniques, Exponential generating function. First order linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Second order linear recurrence relations with constant coefficients, homogeneous, non-homogeneous Solution.

Module - 5 (Algebraic Structures)

Algebraic system-properties- Homomorphism and Isomorphism. Semi group and monoid – cyclic monoid , sub semi group and sub monoid, Homomorphism and Isomorphism of Semi group and monoids. Group- Elementary properties, subgroup, symmetric group on three symbols ,The direct product of two groups, Group Homomorphism, Isomorphism of groups, Cyclicgroup. Rightcosets - Leftcosets. Lagrange's Theorem

Text Book

1. Discrete and Combinatorial Mathematics (An Applied Introduction), Ralph P Grimaldi, B V Ramana , 5th Edition, Pearson

Reference Books

1) Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and Graph Theory, Seventh Edition, MGH, 2011
2) Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 2003.
3) Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, "Discrete Mathematical Structures", Pearson Education Pvt Ltd., New Delhi, 2003
4) Kenneth H .Rosen, "Discrete Mathematics and its Applications", 5/e, Tata Mc Graw Hill Pub. Co. Ltd, New Delhi 2003
5) Richard Johnsonbaugh, "Discrete Mathematics", 5/e, Pearson Education Asia, NewDelhi, 2002.
6) Joe L Mott, Abraham Kandel, Theodore P Baker,"Discrete Mathematics for Computer Scientists and Mathematicians", 2/e, Prentice-Hall India, 2009.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Show that $R \vee M$, $\neg R \vee S$, $\neg M$, $\neg S$ cannot exist simultaneously (without using truth table)
2. Represent the following statement in symbolic form "Not every city in Canada is clean".

Course Outcome 2 (CO2):

1. How many possible arrangements are there for the letters in MASSASAUGA in which 4 A' s are together?
2. Find the number of integers between 1 and 1000 inclusive, which are not divisible by 5, 6 or 8

Course Outcome 3 (CO3):

1. If A = {1, 2, 3, 4}, give an example of a relation R that is reflexive and symmetric but not transitive.
2. Let Z be the set of integers. R is a relation called "Congruence Modulo 3 " defined by R = { (x,y) /x ε Z,y ε Z, x - y is divisible by 3 } . Show that R is an equivalence relation.

Course Outcome 4 (CO4):

1. Assume A ={ a, b, c}. Let P(A) be its power set and '$\leq$ ' be the subset relation on the power set. Draw the Hasse diagram of (P(A), $\leq$).
2. What is meant by Bounded Lattice ? Give an example.

Course Outcome 5 (CO5):

1. Solve $a_r - 3a_{r-1} - 4a_{r-2} = 3^r$ using Generating function method; Given $a_0 = 1$, $a_1 = 2$.
2. Find the generating function for the sequence 1, 3, 3^2, 3^3 …….

Course Outcome 6 (CO6):

1. Prove that the group { 1,-1, i, -i } is cyclic with generators i and –i.
2. State and prove Lagrange's Theorem.

Model Question Paper

QP CODE:

Reg No:_____

Name :_____ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MAT 203

Course Name: Discrete Mathematical Structures

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Show the following implication without constructing the truth table: (P ^ Q) => P→Q
2. Write the negation of the following statement. " If I drive, then I will not walk"
3. What is pigeon hole principle? Explain. If you select any five numbers from 1 to 8 then prove that at least two of them will add up to 9 .
4. In how many ways can the letters of the word ALLAHABAD be arranged ?
5. Show that the divisibility relation ' / ' is a partial ordering on the set Z^+.
6. Consider the functions given by f(x) = 2x+3 and g(x) = x^2. Find (g o f) and (f o g).
7. What is meant by exponential generating function? Explain.
8. Provide one example of linear homogeneous recurrence relation. Mention the degree also.
9. What is a monoid ? Explain.
10. Let (A, .) be a group. Show that $(ab)^{-1} = b^{-1}a^{-1}$

(10 x 3 = 30 Marks)

PART B

(Answer any one Question from each Module. Each question carries 14 Marks)

11.

(a) Show that S ∨ R is tautologically implied by (PVQ) ∧ (P→R) ∧ (Q→S)

(6 marks)

(b) Show that from

(ii) $(\exists x)(F(x) \wedge S(x)) \rightarrow (y)\,(M(y) \rightarrow W(y))$.

(iii)$(\exists y)\,(M(y) \wedge \neg W(y))$ the conclusion $(x)(F(x) \rightarrow \neg S(x))$ follows.

(8 marks)

OR

12.

(a) Show that $(x)\,(P(x) \vee Q(x)) \Rightarrow ((x)P(x) \vee (\exists x)\,Q(x))$ using indirect method of proof .

(6 marks)

(b) Discuss indirect method of proof . Show that the following premises are inconsistent

(i) If Jack misses many classes through illness, then he fails high school.

(ii) If Jack fails high school, then he is uneducated.

(iii)If Jack reads a lot of books, then he is not uneducated.

(iv) Jack misses many classes through illness and reads a lot of books.

(8 marks)

13.

(a) Explain binomial theorem. Determine the coefficient of x^9y^3 in the expansion of $(x+y)^{12}$, $(x+2y)^{12}$ and $(2x-3y)^{12}$ using binomial theorem.

(6 marks)

(b) How many 5 digit numbers can be formed from the digits 1,2,3,4,5 using the digits without repetition ?

(i) How many of them are even?

(ii) How many are even and greater than 30,000?

(8 marks)

OR

14.

(a) There are 8 guests in a party. Each guest brings a gift and receives another gift in return. No one is allowed to receive the gift they bought. How many ways are there to distribute the gifts?

(6 marks)

(b) Six papers are set in an examination of which two are mathematical. Only one examination will be conducted in a day. In how many different orders ,can the papers be arranged so that

(i) Two mathematical papers are consecutive?

(ii) Two mathematical papers are not consecutive?

(8 marks)

15.

(a) Let A = { 1,2,3,4,...11,12} and let R be the equivalence relation on A x A defined by (a,b) R (c,d) iff a+d = b+c. Prove that R is an equivalence relation and find the equivalence class of (2 ,5)

(8 marks)

(b) What is a chain lattice ? Explain. Also show that every chain is a distributive lattice.

(6 marks)

OR

16.

(a) Suppose f(x) = x+2 , g(x) = x-2, and h(x) = 3x for x ε R , where R is the set of real numbers. Find (g o f) , (f o g) , (f o f) and (g o g)

(8 marks)

(b) Let R and S be two relations on a set A . If R and S are symmetric, Prove that (R∩S) is also symmetric.

(6 marks)

17.

(a) Solve the recurrence relation $a_r - 7a_{r-1} + 10a_{r-2} = 0$ for $r \geq 2$; Given $a_0 = 0$; $a_1 = 41$ using generating functions

(8 marks)

(b) Solve the recurrence relation $a_r - 4a_{r-1} + 4a_{r-2} = (r+1)^2$ using generating function.

(6 marks)

OR

18.

(a) Solve $a_n - 3a_{n-1} + 2$; $a_0 = 1$ $n \geq 1$, using generating functions.

(8 marks)

(b) Use generating function to solve the following recurrence relation $a_n = 2a_{n-1} + 2^n$; with $a_0 = 2$.

(6 marks)

19.

(a) Prove that the set 'Q' of rational numbers other than 1 forms an abelian group with respect to the operation ' * ' defined by a * b = a+b -ab.

(8 Marks)

(b) Show that the direct product of two group is a group.

(6 Marks)

OR

20.

(a) Show that the subgroup of a cyclic group is cyclic.

(8 Marks)

(b) Let (A,*) be a group. Show that (A,*) is an abelian group if and only if $a^2 * b^2 = (a*b)^2$ for all 'a' and 'b' in A

(6 Marks)

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module – 1 (Fundamentals of Logic) (9 hrs)		
1.1	Mathematical logic, Basic Connectives and Truth Table	1
1.2	Statements, Logical Connectives, Tautology, Contradiction	1
1.3	Logical Equivalence, The Laws of Logic	1
1.4	The Principle of duality, Substitution Rules	1
1.5	The implication, The Contrapositive, the Converse , the Inverse	1
1.6	Logical Implication,Rules of Inference, Logical Implication	1
1.7	The use of Quantifiers, Open Statement, Quantifier, Negation	1
1.8	Logically Equivalent, Contrapositive, The Converse, The Inverse	1
1.9	Logical Implications	1
Module - 2 (Fundamentals of Counting Theory) (9 hrs)		
2.1	The Pigeon-hole Principle	1
2.2	The Rule of Sum	1
2.3	Extension of Sum Rule	1
2.4	The Rule of Product	1
2.5	Extension of Product Rule , Permutations	1
2.6	Combinations, Combination with repetition	1
2.7	The Binomial Theorem	1
2.8	The Principle of Inclusion and Exclusion Theorem (Without Proof) Generalization of the Principle	1
2.9	Derangements	1
Module - 3 (Relations and Functions) (9 hrs)		
3.1	Cartesian Product, Binary Relation, Function, Domain, Range , One to One Function Image - Restriction	1
3.2	Properties, Reachability Relations, Reflexive Relations,Symmetric Relations,Transitive relations, Antisymmetric Relations.	1

3.3	Partial Order relations	1
3.4	Equivalence Relation, Irreflexive Relations.	1
3.5	Partially ordered Set, Hasse Diagram.	1
3.6	Maximal-Minimal Element, Least Upper bound, Greatest Lower Bound	1
3.7	Equivalence Relations and Partitions ,Equivalence Class	1
3.8	Lattice- Dual Lattice,sub lattice , Properties of glb and lub	1
3.9	Properties of Lattice , Special Lattice , Complete Lattice, Bounded Lattice, Completed Lattice, Distributive Lattice	1
Module - 4 (Generating Functions and Recurrence Relations) (9 hrs)		
4.1	Generating Function , Definition and Examples	1
4.2	Exponential Generating Function.	1
4.3	First Order Linear Recurrence Relations with Constant Coefficients (Lecture I)	1
4.4	First Order Linear Recurrence Relations with Constant Coefficients (Lecture II)	1
4.5	Homogeneous Solution	1
4.6	Non homogeneous Solution	1
4.7	Second order linear recurrence relations with constant coefficients	1
4.8	Homogeneous Solution	1
4.9	Non homogeneous Solution	1
Module - 5 (Algebraic Structures)(9 hrs)		
5.1	Algebraic System-Properties, Homomorphism and Isomorphism	1
5.2	Semi group , Monoid, Cyclic monoid	1

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5.3	Sub semigroup and sub monoid	1
5.4	Homomorphism and Isomorphism of Semigroup, Monoids and Groups	1
5.5	Elementary Properties, Subgroup, Symmetric group on three symbols	1
5.6	The direct Product of two Groups	1
5.7	Group Homomorphism, Isomorphism, Cyclic group	1
5.8	Right coset, Left coset	1
5.9	Lagrange's Theorem	1

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SEMESTER -3

MINOR

CODE	Advanced Linear Algebra	CATEGORY	L	T	P	CREDIT
MAT 281		B. Tech Minor (S3)	3	1	0	4

Preamble: This course introduces the concept of a vector space which is a unifying abstract frame work for studying linear operations involving diverse mathematical objects such as n-tuples, polynomials, matrices and functions. Students learn to operate within a vector and between vector spaces using the concepts of basis and linear transformations. The concept of inner product enables them to do approximations and orthogonal projects and with them solve various mathematical problems more efficiently.

Prerequisite: A basic course in matrix algebra**.**

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

CO 1	Identify many of familiar systems as vector spaces and operate with them using vector space tools such as basis and dimension.
CO 2	Understand linear transformations and manipulate them using their matrix representations.
CO 3	Understand the concept of real and complex inner product spaces and their applications in constructing approximations and orthogonal projections
CO 4	Compute eigen values and eigen vectors and use them to diagonalize matrices and simplify representation of linear transformations
CO 5	Apply the tools of vector spaces to decompose complex matrices into simpler components, find least square approximations, solution of systems of differential equations etc.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	10	10	20
Analyse	10	10	20
Evaluate	15	15	30
Create			

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Show that the $S_1 = \{(x, y, 0) \in R^3\}$ is a subspace of R^3 and $S_2 = \{(x, y, z) \in R^3 : x + y + z = 2\}$ is not a subspace of R^3
2. Let S_1 and S_2 be two subspaces of a finite dimensional vector space. Prove that $S_1 \cap S_2$ is also a subspace. Is $S_1 \cup S_2$ s subspace. Justify your answer.
3. Prove that the vectors $\{(1,1,2,4), (2,-1,5,2), (1,-1,-4,0), (2,1,1,6)\}$ are linearly independent
4. Find the null space of $A = \begin{bmatrix} 1 & 2 & 0 & -1 \\ 2 & 6 & -3 & -3 \\ 3 & 10 & -6 & -5 \end{bmatrix}$ and verify the rank nullity theorem for $m \times n$matrix in case of A

Course Outcome 2 (CO2)

1. Show that the transformation $T; R^2 \to R^3$defined by $T(x, y) = (x - y, x + y, y)$ is a linear transformation.
2. Determine the linear mapping $\varphi; R^2 \to R^3$ which maps the basis $(1,0,0), (0,1,0)$ and $(0,0,1)$to the vectors $(1,1), (2,3)$and$(-1,2)$. Hence find the image of $(1,2,0)$
3. Prove that the mapping $\varphi; R^3 \to R^3$ defined by $T(x, y, z) = (x + y, \quad y + z, z + x)$ is an isomorphism

Course Outcome 3(CO3):

1. Prove that the definition $f(u, v) = x_1y_1 - 2x_1y_2 + 5x_2y_2$for $u = (x_1, y_1)$ and $v = (x_2, y_2)$ is an inner product in R^2.
2. Prove the triangle inequality $\|u + v\| \leq \|u\| + \|v\|$ in any inner product space.
3. Find an orthonormal basis corresponding to the basis $\{1, tcost, sint\}$ of the subspace of the vector space of continuous functions with the inner product defined by $\int_0^{\pi} f(t)g(t)dt$ using Gram Schimdt process .

Course Outcome 4 (CO4):

1. Consider the transformation $T: R^2 \to R^2$ defined by $(x, y) = (x - y, 2x - y)$. Is T diagonalizable. Give reasons.

2. Use power method to find the dominant eigen value and corresponding eigen vector of $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 18 & -1 & -7 \end{bmatrix}$.

3. Prove that a square matrix A is invertible if and only if all of its eigen values are non-zero.

Course Outcome 5 (CO5):

1. Find a singular value decomposition of $\begin{bmatrix} 1 & -1 \\ -1 & 1 \\ 2 & -2 \end{bmatrix}$
2. Find the least square solution to the system of equations
   $x + 2y + z = 1, 3x - y = 2, 2x + y - z = 2, x + 2y + 2z = 1$
3. Solve the system of equations $2x_1 + x_2 + x_3 = 2$,$x_1 + 3x_2 + 2x_3 = 2$, and $3x_1 + x_2 + 2x_3 = 2$ by LU decomposition method.

Syllabus

Module 1

Vector Spaces, Subspaces -Definition and Examples. Linear independence of vectors, Linear span, Bases and dimension, Co-ordinate representation of vectors. Row space, Column space and null space of a matrix

Module 2

Linear transformations between vector spaces, matrix representation of linear transformation, change of basis, Properties of linear transformations, Range space and Kernel of Linear transformation, Inverse transformations, Rank Nullity theorem, isomorphism

Module 3

Inner Product: Real and complex inner product spaces, properties of inner product, length and distance, Cauchy-Schwarz inequality, Orthogonality , Orthonormal basis, Gram Schmidt orthogonalization process. Orthogonal projection. Orthogonal subspaces, orthogonal compliment and direct sum representation.

Module 4

Eigen values, eigenvectors and eigen spaces of linear transformation and matrices, Properties of eigen values and eigen vectors, Diagonalization of matrices, orthogonal diagonalization of

real symmetric matrices, representation of linear transformation by diagonal matrix, Power method for finding dominant eigen value,

Module 5

LU-decomposition of matrices, QR-decomposition, Singular value decomposition, Least squares solution of inconsistent linear systems, curve-fitting by least square method, solution of linear systems of differential equations by diagonalization

Text Books

1. Richard Bronson, Gabriel B. Costa, *Linear Algebra-an introduction,* 2nd edition, Academic press, 2007
2. Howard Anton, Chris Rorres, *Elementary linear algebra: Applications versio,* 9th edition, Wiley

References

1. Gilbert Strang, *Linear Algebra and It's Applications,* 4th edition, Cengage Learning, 2006
2. Seymour Lipschutz, Marc Lipson, *Schaum's outline of linear algebra*, 3rd Ed., Mc Graw Hill Edn.2017
3. David C Lay, *Linear algebra and its applications,3rd edition, Pearson*
4. Stephen Boyd, Lieven Vandenberghe, I*ntroduction to Applied Linear Algebra: Vectors, Matrices,and Least Squares,* Cambridge University Press, 2018
5. W. Keith Nicholson, *Linear Algebra with applications*, 4th edition, McGraw-Hill, 2002

Assignments:

Assignment should include specific problems highlighting the applications of the methods introduced in this course in science and engineering.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Vector spaces (9 hours)**	
1.1	Defining of vector spaces , example	2
1.2	Subspaces	1
1.3	Linear dependence, Basis , dimension	3
1.4	Row space, column space, rank of a matrix	2

1.5	Co ordinate representation	1
2	**Linear Mapping (9 hours)**	
2.1	General linear transformation, Matrix of transformation.	2
2.2	Kernel and range of a linear mapping	1
2.3	Properties of linear transformations,	2
2.4	Rank Nullity theorem.	1
2.5	Change of basis .	2
2.6	Isomorphism	1
3	**Inner product spaces (9 hours)**	
3.1	Inner Product: Real and complex inner product spaces,	2
3.2	Properties of inner product, length and distance	2
3.3	Triangular inequality, Cauchy-Schwarz inequality	1
3.4	Orthogonality, Orthogonal complement, Orthonormal bases,	1
3.5	Gram Schmidt orthogonalization process, orthogonal projection	2
3.6	Direct sum representation	1
4	**Eigen values and Eigen vectors (9 hours)**	
4.1	Eigen values and Eigen vectors of a linear transformation and matrix	2
4.2	Properties of Eigen values and Eigen vectors	1
4.3	Diagonalization., orthogonal diagonalization	4
4.4	Power method	1
4.5	Diagonalizable linear transformation	1
5	**Applications (9)**	
5.1	LU decomposition, QR Decomposition	2
5.2	Singular value decomposition	2
5.3	Least square solution	2
5.4	Curve fitting	1
5.5	Solving systems of differential equations.	2

SEMESTER -3

CODE		CATEGORY	L	T	P	CREDIT
MCN201	SUSTAINABLE ENGINEERING		2	0	0	NIL

Preamble: Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

Prerequisite: NIL

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

CO 1	Understand the relevance and the concept of sustainability and the global initiatives in this direction
CO 2	Explain the different types of environmental pollution problems and their sustainable solutions
CO 3	Discuss the environmental regulations and standards
CO 4	Outline the concepts related to conventional and non-conventional energy
CO 5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

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	3					2
CO 2						2	3					2
CO 3						2	3					2
CO 4						2	3					2
CO 5						2	3					2

Assessment Pattern

Mark distribution

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

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 can have maximum 2 sub-divisions and carry 14 marks.

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the relevance and the concept of sustainability and the global initiatives in this direction

1. Explain with an example a technology that has contributed positively to sustainable development.
2. Write a note on Millennium Development Goals.

Course Outcome 2 (CO2): Explain the different types of environmental pollution problems and their sustainable solutions

1. Explain the 3R concept in solid waste management?
2. Write a note on any one environmental pollution problem and suggest a sustainable solution.
3. In the absence of green house effect the surface temperature of earth would not have been suitable for survival of life on earth. Comment on this statement.

Course Outcome 3(CO3): Discuss the environmental regulations and standards

1. Illustrate Life Cycle Analysis with an example of your choice.
2. "Nature is the most successful designer and the most brilliant engineer that has ever evolved". Discuss.

Course Outcome 4 (CO4): Outline the concepts related to conventional and non-conventional energy

1. Suggest a sustainable system to generate hot water in a residential building in tropical climate.
2. Enumerate the impacts of biomass energy on the environment.

Course Outcome 5 (CO5): Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

1. Suggest suitable measures to make the conveyance facilities used by your institution sustainable.

Model Question paper

Part A

(Answer all questions. Each question carries 3 marks each)

1. Define sustainable development.
2. Write a short note on Millennium Development Goals.
3. Describe carbon credit.
4. Give an account of climate change and its effect on environment.
5. Describe biomimicry? Give two examples.
6. Explain the basic concept of Life Cycle Assessment.
7. Name three renewable energy sources.

8. Mention some of the disadvantages of wind energy.
9. Enlist some of the features of sustainable habitat.
10. Explain green engineering.

Part B

(Answer one question from each module. Each question carries 14 marks)

11. Discuss the evolution of the concept of sustainability. Comment on its relevance in the modern world.

OR

12. Explain Clean Development Mechanism.
13. Explain the common sources of water pollution and its harmful effects.

OR

14. Give an account of solid waste management in cities.
15. Explain the different steps involved in the conduct of Environmental Impact Assessment.

OR

16. Suggest some methods to create public awareness on environmental issues.
17. Comment on the statement, “Almost all energy that man uses comes from the Sun”.

OR

18. Write notes on:
    a. Land degradation due to water logging.
    b. Over exploitation of water.
19. Discuss the elements related to sustainable urbanisation.

OR

20. Discuss any three methods by which you can increase energy efficiency in buildings.

Syllabus

Sustainability- need and concept, technology and sustainable development-Natural resources and their pollution, Carbon credits, Zero waste concept. Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Sustainable urbanization, Industrial Ecology.

Module 1

Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).

Module 2

Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.

Module 3

Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

Module 4

Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.

Module 5

Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.

Reference Books

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
5. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
6. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
7. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
8. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Sustainability	
1.1	Introduction, concept, evolution of the concept	1
1.2	Social, environmental and economic sustainability concepts	1
1.3	Sustainable development, Nexus between Technology and Sustainable development	1
1.4	Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs)	1
1.5	Clean Development Mechanism (CDM)	1
2	Environmental Pollution	
2.1	Air Pollution and its effects	1
2.2	Water pollution and its sources	1
2.3	Zero waste concept and 3 R concepts in solid waste management	1
2.4	Greenhouse effect, Global warming, Climate change, Ozone layer depletion	1
2.5	Carbon credits, carbon trading and carbon foot print.	1
2.6	Legal provisions for environmental protection.	1
3	Environmental management standards	
3.1	Environmental management standards	1
3.2	ISO 14001:2015 frame work and benefits	1
3.3	Scope and Goal of Life Cycle Analysis (LCA)	1
3.4	Circular economy, Bio-mimicking	1
3.5	Environment Impact Assessment (EIA)	1
3.6	Industrial Ecology, Industrial Symbiosis	1
4	Resources and its utilisation	
4.1	Basic concepts of Conventional and non-conventional energy	1
4.2	General idea about solar energy, Fuel cells	1
4.3	Wind energy, Small hydro plants, bio-fuels	1
4.4	Energy derived from oceans and Geothermal energy	1
5	Sustainability Practices	
5.1	Basic concept of sustainable habitat	1
5.2	Methods for increasing energy efficiency of buildings	1
5.3	Green Engineering	1
5.4	Sustainable Urbanisation, Sustainable cities, Sustainable transport	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
			2	0	0	2
EST 200	DESIGN AND ENGINEERING					

Preamble:

The purpose of this course is to

i) introduce the undergraduate engineering studentsthe fundamental principles of design engineering,

ii) make them understand the steps involved in the design process and

iii) familiarize them with the basic tools used and approaches in design.

Students are expected to apply design thinking in learning as well as while practicing engineering, which is very important and relevant for today. Case studies from various practical situations will help the students realize that design is not only concerned about the function but also many other factors like customer requirements, economics, reliability, etc. along with a variety of life cycle issues.

The course will help students to consider aesthetics, ergonomics and sustainability factors in designs and also to practice professional ethics while designing.

Prerequisite:

Nil. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines.

Course Outcomes:

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

CO 1	Explain the different concepts and principles involved in design engineering.
CO 2	Apply design thinking while learning and practicing engineering.
CO 3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

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

Assessment Pattern

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 : 30 marks
part B : 70 marks
Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.
Part B contains 2 case study questions from each module of which student should answer any one. Each question carry 14 marks and can have maximum 2 sub questions.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the different concepts and principles involved in design engineering.

1. State how engineering design is different from other kinds of design

2. List the different stages in a design process.

3. Describedesign thinking.

4. State the function of prototyping and proofing in engineering design.

5. Write notes on the following concepts in connection with design engineering 1) Modular Design, 2) Life Cycle Design , 3) Value Engineering, 4) Concurrent Engineering, and 5) Reverse Engineering

6. State design rights.

Course Outcome 2 (CO2) Apply design thinking while learning and practicing engineering.

1. Construct the iterative process for design thinking in developing simple products like a pen, umbrella, bag, etc.

2. Show with an example how divergent-convergent thinking helps in generating alternative designs and then how to narrow down to the best design.

3. Describe how a problem-based learning helps in creating better design engineering solutions.

4. Discuss as an engineer, how ethics play a decisive role in your designs

Course Outcome 3(CO3): Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.

1. Illustratethe development of any simple product by passing through the different stages of design process

2. Show thegraphical design communication with the help of detailed 2D or 3D drawings for any simple product.

3. Describe how to develop new designs for simple products through bio-mimicry.

Model Question paper

Page 1 of 2

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: EST 200

Course Name: DESIGN AND ENGINEERING

Max. Marks: 100Duration: 3 Hours

PART A

Answer all questions, each question carries 3 marks
Use only hand sketches

(1)Write aboutthe basic design process.

(2) Describe how to finalize the design objectives.

(3) State the role of divergent-convergent questioning in design thinking.

(4) Discuss how to perform design thinking in a team managing the conflicts.

(5) Show how engineering sketches and drawings convey designs.

(6)Explain the role of mathematics and physics in design engineering process.

(7) Distinguish between project-based learning and problem-based learning in design engineering.

(8) Describe how concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?

(9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?

(10) Explain how economics influence the engineering designs?

(10x3 marks =30 marks)

Part B

Answer any ONE question from each module. Each question carry 14 marks

Module 1

(11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.

or

(12)Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

Module 2

(13)Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

or

(14)Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

Module 3

(15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

or

(16)Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

Module 4

(17) Show the development of a nature inspired design for a solar poweredbus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

or

(18)Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

Module 5

(19)Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

or

(20)Describe the how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) anelectrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

(5x14 marks =70 marks)

Syllabus

Module 1

Design Process:- Introduction to Design and Engineering Design, Defining a Design Process-:Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Module 2

Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.

Module 3

Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.

Module 4

Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

Module 5

Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

Text Books

1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,

2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

Reference Books

1.Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420.

2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5

3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361

4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Design Process**	
1.1	Introduction to Design and Engineering Design. *What does it mean to design something? How Is engineering design different from other kinds of design? Where and when do engineers design? What are the basic vocabularyin engineering design? How to learn and do engineering design.*	1
1.2	*Defining a Design Process*-: Detailing Customer Requirements. *How to do engineering design? Illustrate the process with an example. How to identify the customer requirements of design?*	1
1.3	*Defining a Design Process*-: Setting Design Objectives, Identifying Constraints, Establishing Functions. *How to finalize the design objectives? How to identify the design constraints? How to express the functions a design in engineering terms?*	1
1.4	*Defining a Design Process*-: Generating Design Alternatives and Choosing a Design. *How to generate or create feasible design alternatives? How to identify the "best possible design"?*	1
1.5	Case Studies:- Stages of Design Process. *Conduct exercises for designing simple products going through the different stages of design process.*	1
2	**Module 2: Design Thinking Approach**	
2.1	Introduction to Design Thinking *How does the design thinking approach help engineers in creating innovative and efficient designs?*	1
2.2	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. *How can the engineers arrive at better designs utilizing the iterative design thinking process (in which knowledge acquired in the later stages can be applied back to the earlier stages)?*	1
2.3	Design Thinking as Divergent-Convergent Questioning. *Describe how to create a number of possible designs and then how to refine and narrow down to the 'best design'.*	1
2.4	Design Thinking in a Team Environment. *How to perform design thinking as a team managing the conflicts ?*	1
2.5	Case Studies: Design Thinking Approach. *Conduct exercises using the design thinking approach for*	1

	designing any simple products within a limited time and budget	
3	**Module 3: Design Communication (Languages of Engineering Design)**	
3.1	Communicating Designs Graphically. *How do engineering sketches and drawings convey designs?*	1
3.2	Communicating Designs Orally and in Writing. *How can a design be communicated through oral presentation or technical reports efficiently?*	1
	First Series Examination	
3.3	Mathematical Modelling in Design. *How do mathematics and physics become a part of the design process?*	1
3.4	Prototyping and Proofing the Design. *How to predict whether the design will function well or not?*	1
3.5	Case Studies: Communicating Designs Graphically. *Conduct exercises for design communication through detailed 2D or 3D drawings of simple products with design detailing, material selection, scale drawings, dimensions, tolerances, etc.*	1
4	**Module 4: Design Engineering Concepts**	
4.1	Project-based Learning and Problem-based Learning in Design. *How engineering students can learn design engineering through projects?* *How students can take up problems to learn design engineering?*	1
4.2	Modular Design and Life Cycle Design Approaches. *What is modular approach in design engineering? How it helps?* *How the life cycle design approach influences design decisions?*	1
4.3	Application of Bio-mimicry, Aesthetics and Ergonomics in Design. *How do aesthetics and ergonomics change engineering designs?* *How do the intelligence in nature inspire engineering designs? What are the common examples of bio-mimicry in engineering?*	1
4.4	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. *How do concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?*	1
4.5	Case Studies: Bio-mimicry based Designs. *Conduct exercises to develop new designs for simple*	1

	products using bio-mimicry and train students to bring out new nature inspired designs.	
5	**Module 5: Expediency, Economics and Environment in Design Engineering**	
5.1	Design for Production, Use, and Sustainability. *How designs are finalized based on the aspects of production methods, life span, reliability and environment?*	1
5.2	Engineering Economics in Design. *How to estimate the cost of a particular design and how will economics influence the engineering designs?*	1
5.3	Design Rights. *What are design rights and how can an engineer put it into practice?*	1
5.4	Ethics in Design. *How do ethics play a decisive role in engineering design?*	1
5.5	Case Studies: Design for Production, Use, and Sustainability. *Conduct exercises using simple products to show how designs change with constraints of production methods, life span requirement, reliability issues and environmental factors.*	1
Second Series Examination		

Code.	Course Name	L	T	P	Hrs	Credit
HUT 200	Professional Ethics	2	0	0	2	2

Preamble: To enable students to create awareness on ethics and human values.

Prerequisite: Nil

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

CO 1	Understand the core values that shape the ethical behaviour of a professional.
CO 2	Adopt a good character and follow an ethical life.
CO 3	Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.
CO 5	Apply the knowledge of human values and social values to contemporary ethical values and global issues.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1								2			2	
CO 2								2			2	
CO 3								3			2	
CO 4								3			2	
CO 5								3			2	

Assessment Pattern

Bloom's category	Continuous Assessment Tests		End Semester Exam
	1	2	
Remember	15	15	30
Understood	20	20	40
Apply	15	15	30

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10 marks
Continuous Assessment Tests (2 Nos)	:	25 marks
Assignments/Quiz	:	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, 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

Course Outcome 1 (CO1):
1. Define integrity and point out ethical values.
2. Describe the qualities required to live a peaceful life.
3. Explain the role of engineers in modern society.

Course Outcome 2 (CO2)
1. Derive the codes of ethics.
2. Differentiate consensus and controversy.
3. Discuss in detail about character and confidence.

Course Outcome 3(CO3):
1. Explain the role of professional's ethics in technological development.
2. Distinguish between self interest and conflicts of interest.
3. Review on industrial standards and legal ethics.

Course Outcome 4 (CO4):
1. Illustrate the role of engineers as experimenters.
2. Interpret the terms safety and risk.
3. Show how the occupational crimes are resolved by keeping the rights of employees.

Course Outcome 5 (CO5):
1. Exemplify the engineers as managers.
2. Investigate the causes and effects of acid rain with a case study.
3. Explorate the need of environmental ethics in technological development.

Model Question paper

QP CODE: **Reg No:**_____

PAGES:3 **Name :**_____

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

Course Code: HUT 200

Course Name: PROFESSIONAL ETHICS

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

(2019-Scheme)

PART A

(Answer all questions, each question carries 3 marks)

1. Define empathy and honesty.
2. Briefly explain about morals, values and ethics.
3. Interpret the two forms of self-respect.
4. List out the models of professional roles.
5. Indicate the advantages of using standards.
6. Point out the conditions required to define a valid consent?
7. Identify the conflicts of interests with an example?
8. Recall confidentiality.
9. Conclude the features of biometric ethics.
10. Name any three professional societies and their role relevant to engineers.

(10x3 = 30 marks)

PART B

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

MODULE I

11. a) Classify the relationship between ethical values and law?

b) Compare between caring and sharing. (10+4 = 14 marks)

Or

12. a) Exemplify a comprehensive review about integrity and respect for others.

b) Discuss about co-operation and commitment. (8+6 = 14 marks)

MODULE II

13.a) Explain the three main levels of moral developments, deviced by Kohlberg.

b) Differentiate moral codes and optimal codes. (10+4 = 14 marks)

Or

14. a) Extrapolate the duty ethics and right ethics.

b) Discuss in detail the three types of inquiries in engineering ethics (8+6 = 14 marks)

MODULE III

15.**a)** Summarize the following features of morally responsible engineers.

(i) Moral autonomy **(ii)** Accountability

b)Explain the rights of employees (8+6 = 14 marks)

Or

16. a) Explain the reasons for Chernobyl mishap ?

b) Describe the methods to improve collegiality and loyalty. (8+6 = 14 marks)

MODULE IV

17.a) Execute collegiality with respect to commitment, respect and connectedness.

b) Identify conflicts of interests with an example. (8+6 = 14 marks)

Or

18. a) Explain in detail about professional rights and employee rights.

b) Exemplify engineers as managers.

MODULE V

19.**a)** Evaluate the technology transfer and appropriate technology.

b) Explain about computer and internet ethics. (8+6 = 14 marks)

Or

20. a) Investigate the causes and effects of acid rain with a case study.

b) Conclude the features of ecocentric and biocentric ethics. (8+6 = 14 marks)

Syllabus

Module 1 – Human Values.

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Module 2 - Engineering Ethics & Professionalism.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories.

Module 3- Engineering as social Experimentation.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Module 4- Responsibilities and Rights.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality- Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Module 5- Global Ethical Issues.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.

Text Book

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited ,New Delhi,2006.

Reference Books

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

Course Contents and Lecture Schedule

SL.No	Topic	No. of Lectures 25
1	**Module 1 – Human Values.**	
1.1	Morals, values and Ethics, Integrity, Academic Integrity,Work Ethics	1
1.2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1
1.3	Caring and Sharing, Honesty, Courage, Co-operation commitment	2
1.4	Empathy, Self Confidence, Social Expectations	1
2	**Module 2- Engineering Ethics & Professionalism.**	
2.1	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	1
2.2	Moral dilemmas, Moral Autonomy, Kohlberg's theory	1
2.3	Gilligan's theory, Consensus and Controversy,Profession& Professionalism, Models of professional roles, Theories about right action	2
2.4	Self interest-Customs and Religion, Uses of Ethical Theories	1
3	**Module 3- Engineering as social Experimentation.**	
3.1	Engineering as Experimentation, Engineers as responsible Experimenters	1
3.2	Codes of Ethics,Plagiarism, A balanced outlook on law	2
3.3	Challenger case study, Bhopal gas tragedy	2
4	**Module 4- Responsibilities and Rights.**	
4.1	Collegiality and loyalty, Managing conflict, Respect for authority	1
4.2	Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest	2
4.3	Occupational crime, Professional rights, Employee right, IPR Discrimination	2
5	**Module 5- Global Ethical Issues.**	
5.1	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics	2
5.2	Role in Technological Development, Moral leadership	1
5.3	Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	2