Duration: 3hrs **[Max Marks:80]**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, statistical tables if required and state it clearly.

1

a Use Cayley - Hamilton theorem to find $2A^4 - 5A^3 - 7A + 6I$ where $A = \begin{bmatrix} 1 & 2 \\ 2 & 2 \end{bmatrix}$ [5]

b If $\bar{F} = (ax + 3y + 4z)i + (x - 2y + 3z)j + (3x + 2y - z)k$ is solenoidal, find the value of a. [5]

c A discrete random variable has the probability distribution given below [5]

X	-2	-1	0	1	2	3
P(X=x)	0.2	k	0.1	2k	0.1	2k

Find k, mean and variance.

d A continuous random variable with p.d.f. $f[x] = k\, x^2(1-x^3),\ 0 \leq x \leq 1$. Find k [5]
Find mean and variance

2 a [6]

Find eigenvalues and eigen vectors of the matrix $A = \begin{bmatrix} 8 & -8 & -2 \\ 4 & -3 & -2 \\ 3 & -4 & 1 \end{bmatrix}$

b Using Green's theorem evaluate $\int (xy + y^2)dx + x^2 dy$ where c is the closed curve of the region bounded by y = x and $y = x^2$ [6]

C Investigate the association between the darkness of eye colour in father and son from the following. [8]

Color of son's eyes	Color of father's eyes	
	Dark	Not Dark
Dark	48	90
Not Dark	80	782

3 a If $A = \begin{bmatrix} 1 & 2 & -2 \\ 0 & 2 & 1 \\ 0 & 0 & -1 \end{bmatrix}$ then find A^{100} [6]

b The marks obtained by 1000 students in an examination are found to be normally distributed with mean 70 and standard deviation 5. Estimate the number of students whose marks will be i) between 60 and 75 ii) more than 75. [6]

C By using Big M method solve Minimize $Z = 2x_1 + 3x_2$ Subject to $x_1 + x_2 \geq 5$ $x_1 + 2x_2 \geq 6$; $x_1 x_2 \geq 0$ [8]

4 a . Individuals are chosen at random from population and their heights are found to 63,63,64,65,66,69,69,70,71,70 inches. Discuss the suggestions that mean height of the population is
65 inches. [6]

b Show that $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$ is diagonalizable. Also find the diagonal form and the transforming matrix [6]

C Solve the following LPP by simplex method [8]

$$Max.Z = 4x_1 + 10x_2$$

Subject to constraint

$$2x_1 + x_2 \leq 50$$
$$2x_1 + 5x_2 \leq 100$$
$$2x_1 + 3x_2 \leq 90$$
$$x_1, x_2 \geq 0$$

5 a Show that the matrix A is derogatory and find its minimal polynomial A = [6]

$$\begin{bmatrix} 7 & 4 & -1 \\ 4 & 7 & -1 \\ -4 & -4 & 4 \end{bmatrix}$$

b Samples of two types of electric bulbs were tested for the length of life and following data were obtained [6]

	Type I	Type II
No. of samples	8	7
Mean of sample (in hrs.)	1210	1314
Standard Deviation (in hrs.)	36	42

Test at 5% level of significance whether the difference in the sample mean is significant.

C Evaluate by using Stokes theorem $\int xydx + xy^2\,dy$ where c is the square in xy plane with vertices (1,0),(0,1),(-1,0) and (0,-1) [8]

6 a Use the dual simplex method to solve the following LPP [6]

$$Min.Z = 6x_1 + x_2$$

Subject to the constraints

$$2x_1 + x_2 \geq 3$$

$$x_1 - x_2 \geq 0$$

$$x_1, x_2 \geq 0$$

b In a factory production can be achieved by four different workers on five different types of machines a sample study was made for two fold objectives of examining whether the four differ with respect to mean productivity and whether the mean productivity is the same for five different machine. The researcher involved in this study while analysing the collected data ,reports as follows, [6]

1. Sum of squares of variances between machines =35.2
2. Sum of squares of variances between workers =53.8
3. Sum of squares of variances =174.2

Construct an ANOVA table for the given information and draw the interference at 5 % level.

C Reduce the quadratic form $3x_1^2 + 5x_2^2 + 3x_3^2 - 2x_1x_2 - 2x_2x_3 - 2x_3x_1$ into canonical form and hence find rank, index and signature of the matrix [8]

(03 HOURS) **TOTAL MARKS: 80**

Instructions : (1). Question No .1 is compulsory
(2) Answer any ***Three Questions*** from the remaining.
(3) Each full question carries **20** marks.
(4) Assume suitable data, if needed and state it clearly.

Q.1 Attempt any *four o*f the following.

a) Enlist the civil engineering building materials & state their uses in construction. 05M

b) Draw a neat labeled sketch of the 'Modular' burnt clay brick with dimensions as per IS 1077:1992 and enlist the uses of a frog. 05M

c) Enlist the types of mix as per IS456 and explain 'Nominal Mix Concrete'. 05M

d) Define admixture and Explain Water Reducing Admixture's. 05M

e) Classify the types of concrete based on their grades as per IS 456. 05M

f) Enlist the advantages of RMC 05M

Q.2 a) Find-out FM and type of sand sample for the following observations. Also determine the grading zone of sand as per clause No. 6.3 of IS:383-2016 12M

IS Sieve Size	10 mm	4.75 mm	2.36 mm	1.18 mm	600 µ	300 µ	150 µ	R. Pan
Wt. Retained in 'gms.'	0.00	17.64	360.80	330.80	100.85	50.66	39.05	100.20

b) Enlist the methods of curing for ACT method to determine compressive strength of concrete as per IS 9013. Write step by step procedure for 'Boiling water method' of it. 08M

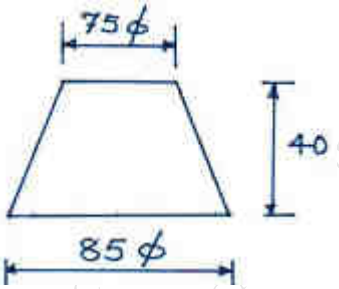
Q.3 a) Enlist the demerits of concrete. 04M

b) Demerits of distemper as compared to paints. 04M

c) Draw a neat labeled sketch of cross-section of a 'Trunk' of a tree. 06M

d) Define NDT of concrete. Enlist the uses and limitations of Schmidt's Rebound Hammer Test. 06M

Q.4 a) Calculate how much quantity of cement is required in grams to perform 'Standard Consistency Test' on a given OPC sample in the laboratory. Take Bulk Density of cement = 1450 Kg/m^{3}and dimensions of a Vicat's mould are in mm as shown in figure. 10M



b) Define workability of a fresh concrete and explain any four factors affecting of it. 10M

Q.5 a) The following table gives compressive strength in N/mm^2 of 20 numbers of concrete cubes tested in a laboratory. Determine Standard deviation of concrete. 12M

Sample No.	Comp. Strength	Sample No.	Comp. Strength	Sample No.	Comp. Strength	Sample No.	Comp. Strength
1	22	6	25	11	27	16	29
2	23	7	26	12	28	17	30
3	24	8	26	13	28	18	30
4	24	9	27	14	29	19	31
5	25	10	27	15	29	20	31

b) Enlist the various components of RMC plant and draw a neat layout sketch of RMC plant. 08M

Q.6 a) Explain dressing of a stone and draw a neat sketch of Punched Dressing. 04M

b) Enlist the properties of glass. 04M

c) Enlist any four physical properties of CA and explain their influence on properties of concrete. 06M

d) Explain steps involved in manufacturing process of concrete 06M

Data for Q. 2 a)

Grading Limits for Fine aggregates (Sand), As per Clause No. 6.3 of IS 383 :2016.

IS Sieve Designation	Percentage passing by weight for			
	Zone-I Grading	Zone-II Grading	Zone-III Grading	Zone-IV Grading
10 mm	100	100	100	100
4.75 mm	90 - 100	90 - 100	90 - 100	95 - 100
2.36 mm	60 - 65	75 - 100	85 – 100	95 - 100
1.18 mm	30 - 70	35 - 90	75 - 100	90 - 100
600 µ	15 - 34	35 - 59	60 - 79	80 - 100
300 µ	5 - 20	8 - 30	12 - 40	15 - 50
150 µ	0 - 10	0 - 10	0 - 10	0 - 15

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(3 Hours) **[Total Marks: 80]**

N.B.: 1) Question No. **1** is **Compulsory**.
2) Answer **any THREE** questions from Q.2 to Q.6.
3) Figures to the right indicate full marks.

Q.1 (a) Evaluate $\int_0^{1+i}(y+ix^2)\,dz$ along the parabola $y = x^2$. (5)

(b) $If\ \overline{F} = (x+2y+az)i + (bx-3y-z)j + (4x+cy+2z)k$ is irrotational then find the values of a, b, c (5)

(c) A continuous random variable has pdf $f(x) = ke^{-x}, 0 \le x < \infty$. Determine k, mean, variance. (5)

(d)

x	3	5	4	6	2
y	3	4	5	2	6

(5)

Calculate the Karl Pearson's coefficient of correlation .

Q.2 (a) The following are the marks scored by students in two tests in a subject. Calculate Spearman's rank correlation coefficient of from the following data. (6)

Marks in Test 1	18	20	34	52	12
Marks in Test 2	39	23	35	18	46

(6)

(b) Find the MGF of a random variable X whose p.m.f is given by

x	0	1	2	3
P(x)	1/18	1/9	5/18	10/18

. Hence find mean and Variance of X.

(c) Obtain all possible Laurent's series expansion of $f(z) = \frac{z}{(z-1)(z-2)}$ about $z = 0$. (8)

Q.3 (a) Three urns are there containing white and black balls; first urn has 3 white and 2 black balls, second urn has 2 white and 3 black balls and third urn has 4 white and 1 black balls. Without any biasing one urn is chosen from that one ball is chosen randomly which was white. What is probability that it came from the third urn? (6)

(b) Fit the second degree polynomial for following data (6)

X	1	2	3	4	5	6	7
Y	-5	-2	5	16	31	50	73

(c) Prove that $\overline{F} = (2xy+z)i + (x^2+2yz^3)j + (3y^2z^2+x)k$ is conservative. Find scalar potential of $\overline{F}$. Hence find the work done of moving particle from $(1,2,0)$ to $(2,2,1)$. (8)

Q.4 (a) Using Green's Theorem evaluate $\int_c (x^2 - y)dx + (y^2 + x)dy$ and c is closed curve of the region bounded by $y = 4$ and $y = x^2$. (6)

(b) Samples of two types of electric bulbs were tested for length of life and following data were obtained (6)

	Type I	Type II
Number of samples	8	7
Mean of samples(in hour)	1134	1024
Standard Deviation(in hour)	35	40

Test at 5% level of significance whether the difference in the sample means is significant.

(c) In a normal Distribution, 30% of students scored below 35 and 10% scored above 60. Find the mean and standard deviation. (8)

Q.5 (a) The standard deviation from two random samples of sizes 9 and 13 are 1.99 and 1.9. Can the samples be regard as drawn from normal population with same standard deviation?$(F_{(8,12)}(0.025) = 3.51, F_{(12,8)}(0.025) = 4.20)$ (6)

(b) Use Gauss's Divergence Theorem to evaluate $\iint_s \overline{N}.\overline{F}\ ds$, where $\overline{F} = 4xi - 2y^2j + z^2k$ and S is region bounded by $x^2 + y^2 = 4, z = 0, z = 4$. (6)

(c) Obtain both Line of regressions for the data given below (8)

X	65	66	67	67	68	69	70	72
Y	67	68	65	68	72	72	69	71

Also find X for Y = 70.

Q.6 (a) Evaluate $\int_c \frac{z+3}{(2z^2+3z-2)}dz$, where c is the circle |z-i|=2. (6)

(b) The following data relate to marks obtained by 11 students in 2 tests, one held at the beginning of the year and the other at the end of the year after intensive coaching: (6)

Test 1	19	23	16	24	17	18	20	18	21	19	20
Test 2	17	24	20	24	20	22	20	20	18	22	19

(c) The following table gives the number of accidents in a district during a week. Apply χ^2 test to find whether the accidents are uniformly distributed over the week. (8)

Day	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
No. of days	13	12	11	9	15	10	14

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Time: 3 Hrs **Marks: 80**

N.B. 1) Question No.1 is Compulsory.
2) Attempt any Three questions from remaining questions.
3) Assume suitable data where required and clearly state the same.
4) Figures to the right indicate full marks.

Q.NO. 1 Attempt **any four** **(20)**

a) Explain the term co-efficient of friction on what factors does this coefficient depend?

b) Derive the expression for diameter of nozzle for maximum transmission of power through nozzle.

c) write a short note on laminar flow.

d) obtain an expression for velocity distribution for turbulent flow in smooth pipes.

e) Define energy thickness? derive its equation

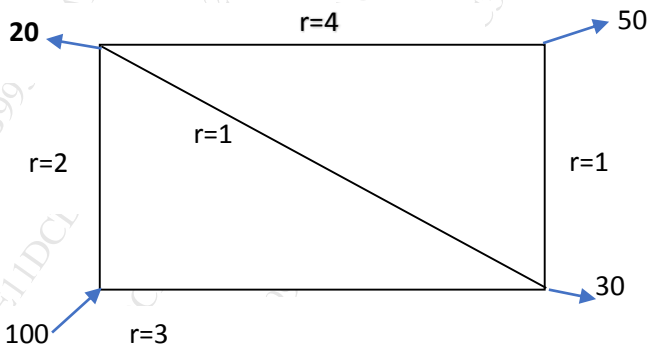
f) Explain Froude's model law

Q.NO. 2 a) A siphon of diameter 200 mm connects two reservoirs having difference of **(10)** elevation of 16 m. The total length of siphon is 600 mm and the summit is 5 m above the water level in the upper reservoir, if separation takes place at a 2.8 m of water absolute. Find maximum length of siphon from upper reservoir to summit. take friction factor = 0.004 atmospheric pressure is 10.3 m of water.

b) 300 mm diameter Horizontal pipe is suddenly enlarged to 600 mm. the rate of flow of **(10)** water through pipe is 130 KN/m^3. determine i) loss if head due to sudden enlargement

ii)Intensity of pressure in larger pipe. iii) power lost due to enlargement.

Q.NO. 3 a) calculate the discharge in each pipe of the network shown in fig below by **(10)** Hardy cross method.



b) Two parallel plates kept 200 mm apart have laminar flow of oil between them with a maximum velocity of 1.6 m/s calculate i) the discharges per meter width ii) the shear stress at plates iii) the difference in pressure between two points 20 m iv) the velocity gradient at the plate v) the velocity 20mm from the plate. Assume viscosity of oil to be 24.5 poise. **(10)**

Q.NO. 4 a) i) Explain hydrodynamically rough and smooth boundary. **(5)**

ii) Explain boundary layer separation and its control. **(5)**

b) Experiment were conducted in a wind tunnel with a wind speed of 56 km /hr on a flat plate of size 2 m long and 1 m wide. the density of air is 1.20 kg/m^3. the coefficient of lift and drag 0.75 and 0.15 respectively determine i) lift force ii) drag force iii) resultant force iv) direction of resultant force. **(10)**

Q.NO. 5 a) i) Explain magnus effect in detail. **(5)**

ii) Write a short note on "Moment of Momentum principle. **(5)**

b) A 20 cm diameter pipe carries water under a head of 12 m with velocity of 3 m/s. if the axis of the pipeline turns through 45˚, find the magnitude and direction of resultant force at the bend **(10)**

Q.NO. 6 a) The force f on the propeller of an aircraft is known to depend upon speed of the aircraft V, air density ρ , air viscosity μ, propeller diameter D , speed of rotation of propeller N , Derive an expression for force F. **(10)**

b) A spillway model is to be made to a scale of 1/25 across a flume which is 0.5 m wide. The prototype is 15 m high and the maximum head expected is 2 m. **(10)**

i) What height of model and what head on model should be used

ii) If the flow over the model at 6 cm head is 0.02 m^3/ s, what flow per metre length of prototype may be expected.

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(3 Hours) **[Total Marks: 80]**

NOTE:

- **Question No. 1 is compulsory.**
- **Attempt any Three out of the remaining five questions.**
- **Figure to the right indicates full marks. Draw neat sketches wherever necessary.**
- **Assume suitable data wherever required.**

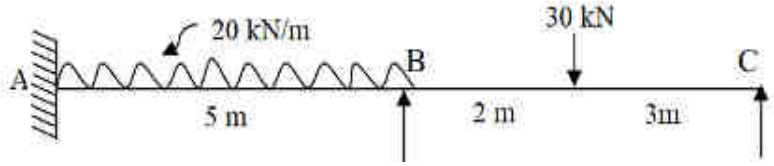
Q.1 Answer **any four** from the following. 20

(a) A three hinged parabolic arch has a span of 30 meters and a rise of 10m. The arch carries a uniformly distributed load of 50 kN per meter on the left half of the span. It also carries a concentrated load of 160 kN at 5m from right end. Determine the horizontal thrust at each support. 05

(b) Find the shape factor for a beam of solid circular section of radius R. 05

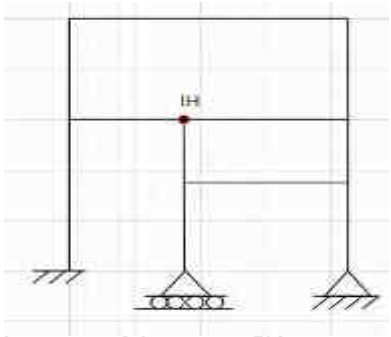
(c) A simply supported girder has a span of 15m. Two-wheel loads of 100 kN and 50 kN spaced at 2m moves on the girder. Find the bending moment that can occur at a section 8m from the left end. Any wheel load can lead the other. 05

(d) Analyse the beam using stiffness method and find the rotations. I is constant. 05

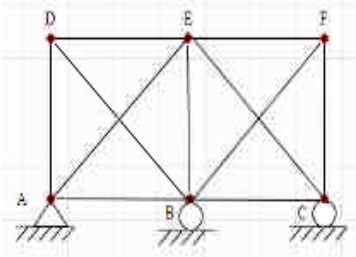


(e) Find the static and kinematic indeterminacy of the structures given below. 05

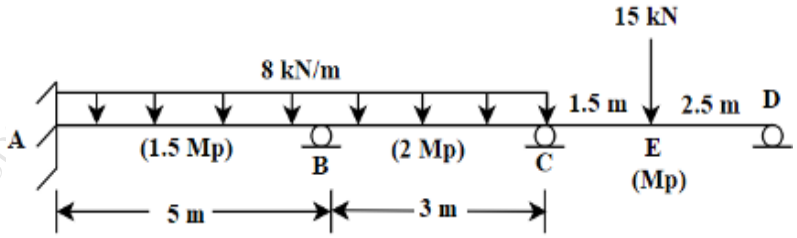
i)



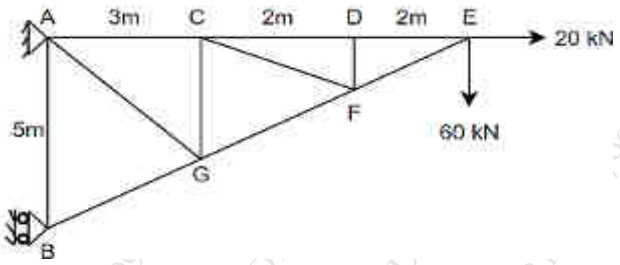
ii)



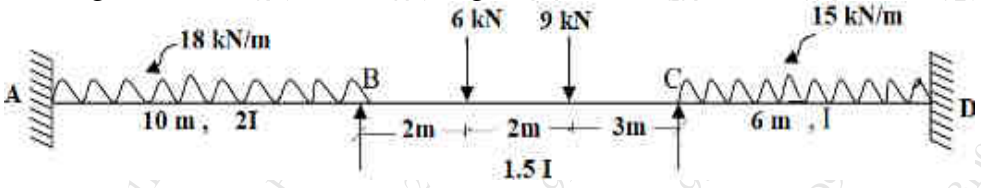
Q.2 (a) Find the Plastic Moment 'Mp' for the continuous beam given below. 08



(b) Find the forces in the members of the truss given below using the method of joints. 12

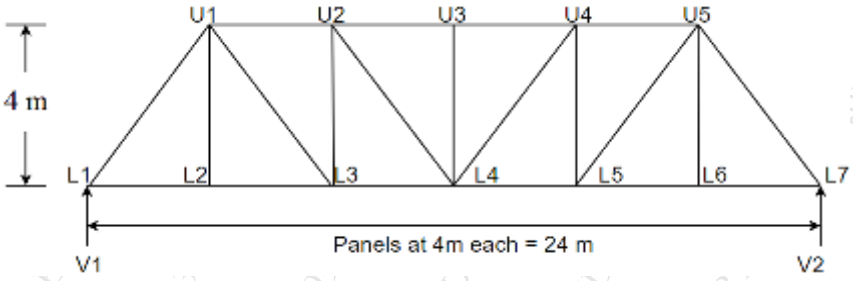


Q.3 (a) Analyse the frame given below using **moment distribution method**. Draw the bending moment and shear force diagram. 12

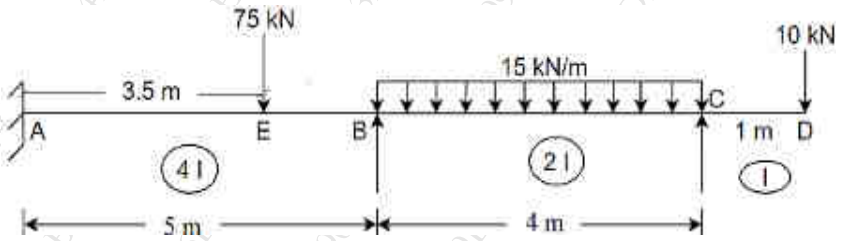


(b) Draw the influence line diagram for the following members: 08

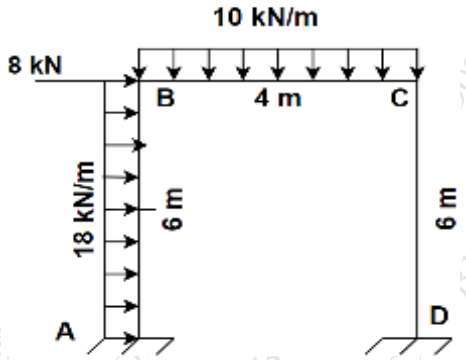
1. Top Chord Member: U_1U_2
2. Top Chord Member: U_2U_3
3. Bottom Chord Member: L_3L_4
4. Vertical Chord Member: U_1L_2



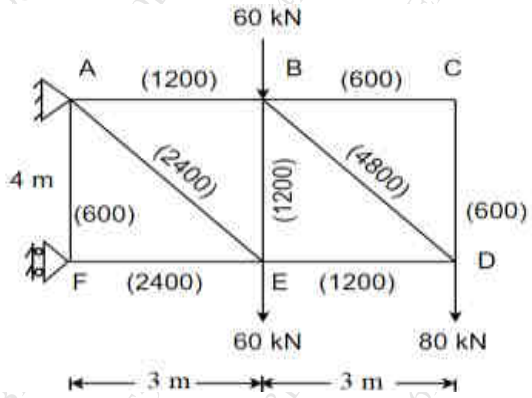
Q.4 (a) Analyse the continuous beam by Clapeyron's Theorem. Draw the bending moment and shear force diagram. 08



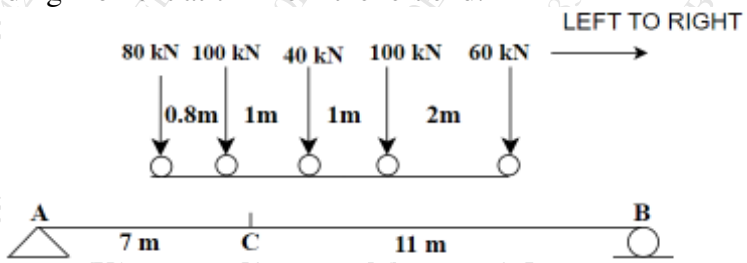
(b) Using **Stiffness matrix method**, analyze the given portal frame. Draw the Bending moment Diagram. Consider I to be constant. 12



Q.5 (a) Find the Vertical and Horizontal deflection at D (Δ_{VD} & (Δ_{HD}) using unit load method of the truss given below. The cross-sectional areas in mm^2 of various member are given in the brackets. 12
Take E = 200 kN/mm^2.

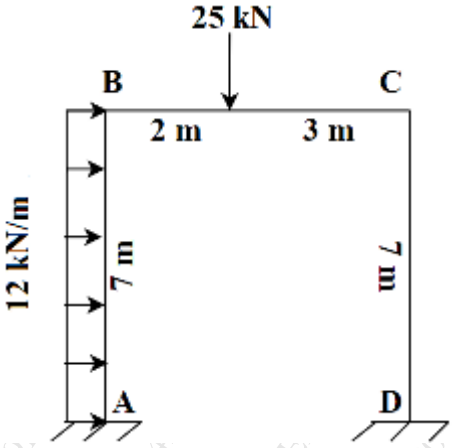


(b) The wheel loads as shown in the figure moves over a girder of 18m. Find the maximum bending moment at 7m from the left end. 08



Q.6 (a) A three hinged parabolic arch ACB is hinged at the supports A and B which are below the crown hinge by 4m and 16m respectively. The span of the arch is 30m. The arch carries a uniformly distributed load of 55 kN/m from A to C. Find the reactions at the supports and the maximum positive and negative bending moment. 08

(b) The portal frame ABCD is loaded and supported as shown below. Use **flexibility method** for analysis, draw the bending moment diagram. AB = 2I, BC = CD = I. 12



Time: 3hours **Max Marks: 80**

Question 1 is compulsory
Attempt any three from remaining
Assume suitable data wherever necessary and mention it clearly.
Figures to the write indicate full marks.
Attempt sub questions in order.

1. Write a brief note on any four of the following

a. Ranging and types of ranging (05)
b. Characteristics of contour lines (05)
c. Fundamental lines or axes of a theodolite. (05)
d. Working principle of EDM and its uses in Surveying. (05)
e. Necessity and types of curves. (05)

2a. Explain the terms contour interval and horizontal equivalent (05)
b. Differentiate between Prismatic and Surveyor compass. (05)
c. Bearings observed in a compass travers with a compass are given below. Find the station affected by local attraction and correct the bearings. Also find the true bearings of the lines if the magnetic declination is 4^0 30' W Tabulate the corrected bearings. (10)

Line	Fore Bearing	Back Bearing
AB	305° 00'	125° 30'
BC	75° 30'	254° 30'
CD	115° 30'	297° 00'
DE	165° 30'	345° 30'
EA	225° 00'	44° 00'

3 a. Discuss in detail about the field procedure of profile levelling and cross sectioning with necessary diagrams. (10)
b. Determine the missing data. Apply usual checks. (10)

Station	B.S.	I.S	F.S.	Rise	Fall	H.I.	RL(m)
1	?					23.18	20.00
2		1.59		?			?
3	0.28		?		1.08	?	?
4	?		4.00		?	18.33	?
5		?			2.19		?
6	?			?			15.72
7			2.95		?		?

4.
a. Following data belongs to a theodolite traverse. Balance the traverse using transit rule. (05)

Line	Length	Latitude	Departure
AB	300.00	+129.56	+4.52
BC	147.60	+17.27	+299.58
CD	307.20	-147.53	+4.94
DA	129.60	0	-307.20

b. Explain temporary adjustments of a transit theodolite. (5)
c. Discuss the difficulties in chaining. (5)
Following offsets were taken from a chain line to an irregular boundary. (5)
d. Calculate the area enclosed by the chain line, the irregular boundary and the offsets using Simpson's rule & trapezoidal rule:

Distance in m	0	6	12	18	24	36	48	60	72
Offset in m	3.8	3.0	2.9	1.8	1.6	1.6	1.5	1.8	3.2

5

a. Explain the different methods used for orientation of plane table. (5)

b. Discuss the function and components of GPS. (5)

c. Following observations were made on a vertically held staff with a tacheometer set up on an intermediate point on a straight-line CD. The instrument was fitted with an anallatic lens and had a multiplying constant as 100. Compute the length CD and the RL of D. RL of C is 527.63m (10)

Staff station	Vertical Angle	Staff intercept	Axial hair reading
C	+8° 36’	2.880	2.505
D	-8° 36’	1.655	2.850

6.

a. Explain methods of tacheometry and its suitability. (05)

b. Discuss the procedure for setting out deflection angle using theodolite. (5)

c. Tabulate the necessary data for setting out a simple circular curve with the following data. Angle of intersection = 144°; chainage of point of intersection = 1390m.; Radius of the curve = 300m.The curve is to be set out by offsets from chords produced with pegs at every 20m throughout the chainage. (10)