**[3 hours]** **[Total Marks 80]**

N.B. (1) Question No. 1 is compulsory
(2) Attempt any THREE from the remaining Q2 to Q6
(3) Use of statistical table is allowed.

1. (a) Prove that **F**= (x+2y+4z)i+(2x-3y-z)j+(4x-y+2z)k is solenoidal (5)

(b) Maximize $Z = x_1 - 2x_2 + 4x_3$
Subject to constraints $x_1 + 2x_2 + 2x_3 + 8x_4 = 7$ ; $3x_1 + 4x_2 + 6x_3 = 15$. (5)
$x_1, x_2, x_3 \geq 0$ then find (i) all basic solutions

(c) 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

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

2. (a) Find the Eigen values and Eigen vectors of the matrix $\begin{bmatrix} 2 & -1 & 1 \\ 1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$ (6)

(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) using Dual Simplex method solve minimize $z = -3x_1 - 2x_2$ sub. $x_1+2x_2 \geq 1$, $x_1+x_2 \leq 7$, $x_1+2x_2 \leq 10$ , $x_1, x_2 \geq 0$ (8)

3. (a) If the vector field $\bar{F}$ is irrotational find the constants a,b,c where
$\bar{F}$ = (x + 2y + az)i + (bx – 3y –z)j + (4x + cy + 2z) k. (6)

(b) By using Big M method solve Minimize $Z = 2x_1 + 3x_2$ Subject to $x_1 + x_2 \geq 5$ (6)
$x_1 + 2x_2 \geq 6$ ; $x_1\, x_2 \geq 0$

(c) 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, (8)

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.

4. (a) If $A = \begin{bmatrix} 1 & 2 & -2 \\ 0 & 2 & 1 \\ 0 & 0 & -1 \end{bmatrix}$ then find $A^{100}$ (6)

(b) By using simplex method solve Maximize $Z = 4x_1 + 8x_2 + 5x_3$ (6)
Subject to $x_1 + 2x_2 + 3x_3 \leq 18$ ; $2x_1 + 6x_2 + 4x_3 \leq 15$ ;
$x_1 + 4x_2 + x_3 \leq 6$; $x_1, x_2, x_3 \geq 0$

(c) 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. (8)

5. (a) Show that the matrix A is derogatory and find its minimal polynomial

$$A = \begin{bmatrix} 7 & 4 & -1 \\ 4 & 7 & -1 \\ -4 & -4 & 4 \end{bmatrix}$$ (6)

(b) It is shown that the probability of an item produced by a certain machine will be defective is 0.05. If the produced items are sent to the market in packets of 20, find the number of packets containing (i)at least 3 (ii) exactly 3 (iii) at most three defective items in a consignment of 1000 packets using Poisson Distribution (6)

(c) Based on the following data determine if there is a relation between literacy and smoking using $\chi 2$ test. (8)

| | Smokers | Non-smokers |
|---|---|---|
| Literates | 83 | 57 |
| Illiterates | 45 | 68 |

6. (a) Use Gauss divergence theorem to evaluate where $\iint \bar{N} \cdot \bar{F}\, ds$ where $\bar{F} = \left(4x\hat{\imath} - 2y^2\hat{\jmath} + z^2\hat{k}\right)$ and S is the region bounded by $x^2 + y^2 = 4$ , $z = 0$ , $z = 3$ (6)

(b) Can it be concluded that average life span of an indian is more than 70 years. ,if a random sample of 100 indians has an average life span of 71.8 years with standard deviation of 7.8 years? (6)

(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)

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

**Instructions:** (1) Question No.1 is compulsory
(2) Answer any **Three Questions** from the remaining questions.
(3) Draw neat sketches wherever essential.

**Q1. Attempt any four out of six.** **5 Marks Each**

A) Enlist building construction materials and write their roles in construction
B) Explain the seasoning of stones.
C) State physical properties of OPC as per IS code and explain 'Normal Consistency' of cement.
D) Define workability of fresh concrete and explain factors affecting of it
E) What are the objectives in mix design?
F) Enlist advantages of RMC.

**Q2**. A) Explain any five properties of CA and their influence on properties of concrete **(10M)**
B) Enlist the ingredients of mortar and its applications. **(05M)**
C) What is admixture? State the various functions of admixture. **(05M)**

**Q3**. A) What is the name of IS code to measure the workality of fresh concrete? Explain any one method to measure workality of fresh concrete. **(10M)**
B) Explain the dry process of manufacturing of cement. **(06M)**
C) Draw a neat labeled sketch of Modular burnt clay brick with dimensions. **(04M)**

**Q4**. A) Enlist the various components of RMC plant and draw a neat layout sketch of RMC plant **(10M)**
B) Enlist the methods of determining compressive strength of accelerated cured concrete test specimens as per IS 9013 – 2004. Explain any one of them. **(10M)**

**Q5**. A) Explain types of concrete mixes as per IS 456. **(06M)**
B) Explain Step-by-step procedure to determine Standard Consistency of a cement sample in the laboratory by mentioning IS code of it. **(08M)**
C) What are the various methods of NDT? Describe any one with sketch. **(06M)**

**Q6**. A) Explain demerits of distemper as compared to paints. **(05M)**
B) Draw a cross-section of a 'Trunk' of a tree and labeled it. **(05M)**
C) Write a note on quality of water for concrete. **(05M)**
D) Classify concrete based on their grades as per IS 456. **(05M)**

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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) What is the value of $\int_0^{1+i} \left(x - y + ix^2\right) dz$ along the line from $z = 0$ *to* $z = 1 + i$ **(5)**

(b) Find a and b such that $\vec{F} = (axy + z^3)i + x^2 j + bz^2 xk$ is irrotational **(5)**

(c) A random variable X has probability mass function p(x) =k$x^3$ ; x=1,2,3,4 then find the value of k , mean, variance. **(5)**

(d) Find the probability that at most 4 defective bulbs will be found in a box of 200 bulbs if it is known that 2% of the bulbs are defective. **(5)**

**Q.2** (a) Find the rank correlation coefficient between X and Y ; **(6)**

| X | 17 | 13 | 15 | 16 | 6 | 11 | 14 | 9 | 7 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 36 | 46 | 35 | 24 | 12 | 18 | 27 | 22 | 2 | 8 |

(b) A random variable has the MGF $M_X(t) = \frac{3}{3-t}$. Find mean and Variance of X. **(6)**

(c) Obtain Laurent's series expansions of f(x) = $\frac{z-1}{z^2-2z-3}$ ;$|z| > 3$. **(8)**

**Q.3** (a) A coin is tossed. If it turns up heads two balls are drawn from urn A otherwise two ballsare drawn from urn B. Urn A contains 3 black and 5 white balls. Urn B contains 7 blackand one white ball. What is the probability that urn A was used, given that both ballsdrawn are black? **(6)**

(b) Fit a straight line $y = a + bx$ into the given data. **(6)**

| *x:* | 10 | 20 | 30 | 40 | 50 |
|---|---|---|---|---|---|
| *y:* | 22 | 23 | 27 | 28 | 30 |

(c) Prove that$\overline{F} = (6xy^2 - 2z^3)i + (6x^2 y + 2yz)j + (y^2 - 6z^2 x)k$ is irrotational. Find scalar potential of $\overline{F}$ . Hence find the work done of moving particle from $(1,0,2)$ to $(0,1,1)$. **(8)**

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

(b) A machinist is expected to make engine parts with axle diameter of 1.75 cm. A random sample of 10 parts shows a mean diameter of 1.85 cm, with a S.D of 0.1 cm. Based on this sample, would you say that the work of the machinist is inferior? **(6)**

(c) A random variable X follows a normal distribution with mean 14 and standard deviation 2.5 find (1 )P[X<8] (2) P[X>18] (3) P[12<X<15] Given: Area between z=0 and z=2.4 is 0.4918 ; Area between z=0 and z=1.6 is 0.4452 ; Area between z=0 and z=0.8 is 0.2882 ; Area between z=0 and z=0.4 is 0.1554. **(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 $\overline{F} = 4xi - 2y^2 j + z^2 k$ 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)**
Given $\sum X = 250$ ; $\sum Y = 300$; $\sum XY = 7900$;$\sum X^2$=6500; $\sum Y^2$ =10000 and n =10 (in usual notation)

**Q.6** (a) Evaluate Value of $\int_c \frac{sin2z\ dz}{(z + \pi/3)^4} dz$is where C:$|z| = 2$ **(6)**

(b) The following data find the correlation coefficient 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) A die was thrown 132 times and the following frequencies were observed. **(8)**

| No. obtained | 1 | 2 | 3 | 4 | 5 | 6 | Total |
|---|---|---|---|---|---|---|---|
| Frequency | 15 | 20 | 25 | 15 | 29 | 28 | 132 |

Test the hypothesis that the die is unbiased at 5% level of significance.

(Given: Table value of $\chi^2$ at 5% level of significance and 5 degree of freedom is 11.07)

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**Duration-3hrs** **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.1 Attempt any four. **(20)**

a) Obtain expression for head loss in a sudden expansion in the pipe.

b) Explain the terms distorted and undistorted models.

c) Discuss the phenomenon of boundary layer separation in diverging flow.

d) Explain Dash-Pot mechanism in laminar flow.

e) Compare hydrodynamically smooth and rough pipes.

f) Explain moment of momentum equation.

Q.2a) for the distribution main of a city water supply a 30 cm main is required. As pipes above 25cm diameter are not available. It is decided to lay two parallel mains of same diameter. Find the diameter of the parallel main. **(10)**

b) What is meant by water hammer? Obtain an expression for the rise in pressure in a thin elastic pipe of circular section in which the flow of water is stopped by sudden closure of value. **(10)**

Q.3a) Explain in detail Hardy cross method for pipe network. **(10)**

b)An aeroplane travels in air of pressure 1 bar of 10º c at a speed of 1700 km/hr. find the Mach number and Mach angle take K= 1.4 & R = 287 J/kg.k. **(10)**

Q.4 a) for the following types of velocity distribution obtain the values of $(\delta^*/\delta)$ and $(\Theta/\delta)$

i) $\frac{v}{V}=2\eta-\eta^2$ ii) $\frac{v}{V}=2\eta-2\eta^2+\eta^4$ where $\eta = (y/\delta)$. **(10)**

b) Two parallel plates kept 10cm a part have laminar flow of oil between them with a maximum velocity of 1.5mlsec. Calculate the discharge per meter width the shear stress at the plates, the difference in pressure in kg/cm$^2$ between two points 20 m apart, the velocity gradient at the plates and velocity 2 cm from the plate. Take viscosity of oil to be 0.25 kg sec /m$^2$. **(10)**

Q.5 a) 250 litres of water is flowing in a pipe having a diameter of 300mm. If the pipe is bend by135$^0$.Find the magnitude and direction of the resultant force on the bend. The pressure of water flowing is 400 KN/m$^2$. Take w = 9.81 KN/m$^3$. **(10)**

b) A crude oil of viscosity 0.97 poise and relative density is 0.9 flowing through a horizontal circular pipe of diameter 100 mm and oil length 10m. Calculate the difference of pressure at the two ends of the pipe. If 100 kg of the oil is collected in a tank in 30 seconds. **(10)**

Q.6 a) Derive Prandtl's Universal velocity distribution equation for turbulent flow in pipes what do you understand velocity defects. **(10)**

b) The pressure difference $\Delta p$ in a pipe of diameter D and the length l due to turbulent flow depends on the velocity Viscosity density $\rho$ and roughness K using Buckingham's $\pi$ theorem obtain an expression for $\Delta p$. **(10)**

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

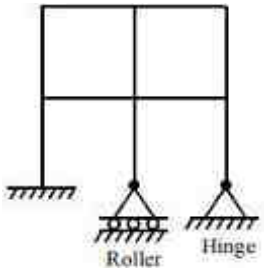
**NOTE:**

- **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.**

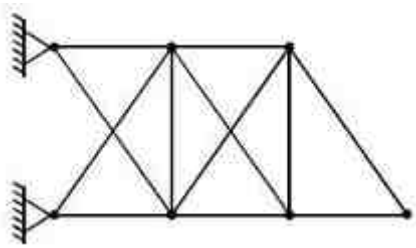
**Q.1** Answer **any four** from the following. **20**

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

i)




ii)

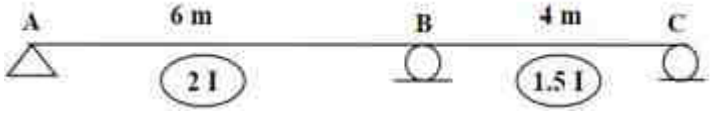


(b) State the assumptions in plastic theory. **05**

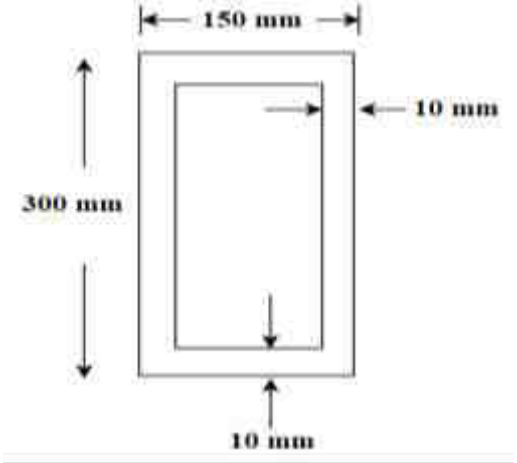
(c) A three hinged parabolic arch of span L and rise h carries a uniformly distributed load of 'w' per unit over the whole span. Show that the arch is not subjected to any bending moment at any section. **05**

(e) Two-wheel loads 70kN and 120kN spaced at 5m apart move on a girder of span 20m. Find the maximum positive and negative shear force at a section 8m from the left end. Any wheel load can lead the other. **05**

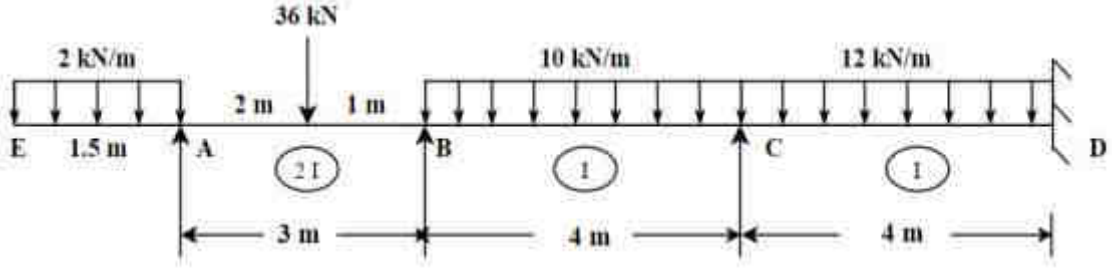
(f) Develop the stiffness matrix for the structure given below: **05**



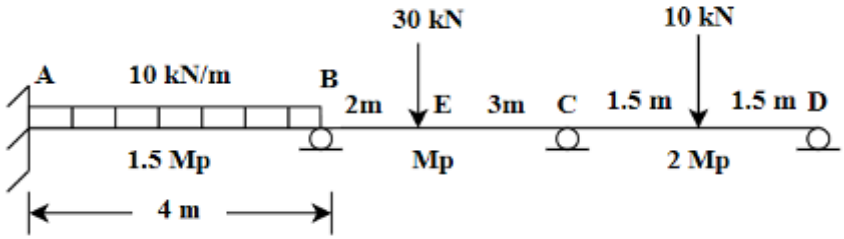

**Q.2** (a) Determine the shape factor for the steel beam section given below. Also find the plastic moment of resistance. Take yield stress of steel as 250 N/mm$^2$. **05**



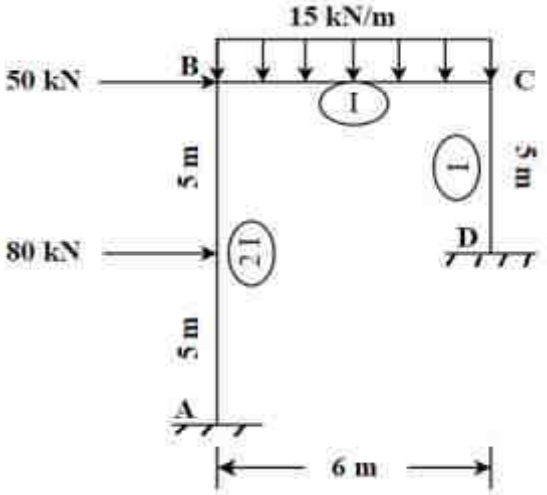
(b) Analyse the beam given below using **moment distribution method**. Draw the bending moment and shear force diagram. **15**



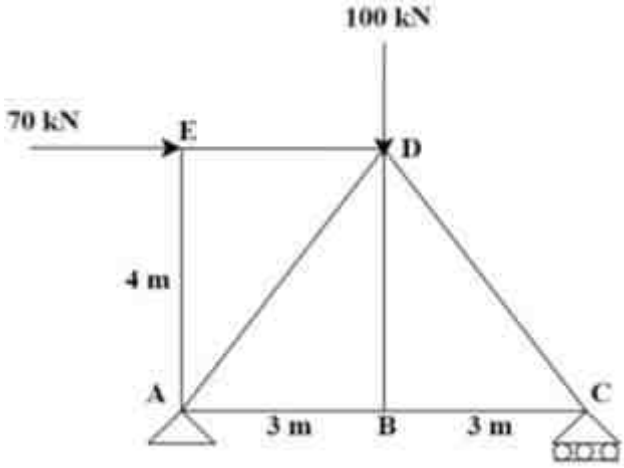

**Q.3** (a) Find the Plastic Moment 'Mp' for the continuous beam given below. **10**



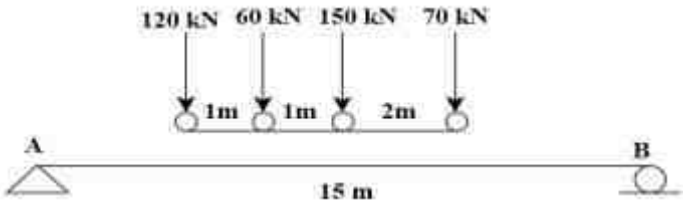

(b) Using **Stiffness matrix method**, analyze the given portal frame. Draw the Bending moment Diagram. **10**




**Q.4** (a) Find the forces in the members of the truss given below using the method of joints. **10**

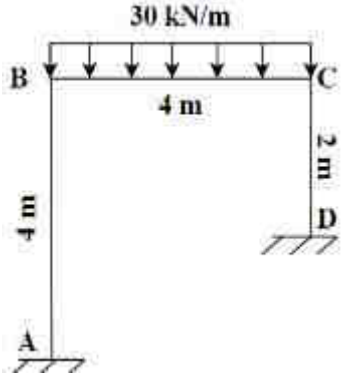


(b) Find the absolute maximum bending moment on the girder with 70 kN load leading & moving from left to right. **10**

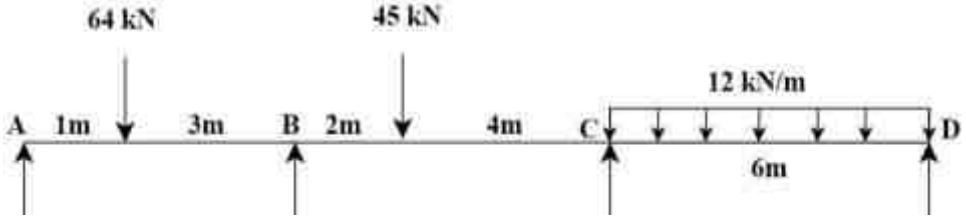



**Q.5** (a) A three hinged parabolic arch (same level) has a span of 30m and a rise of 10m. The arch carries a UDL of 60 kN/m on the left half of its span. It also carries two concentrated loads of 160kN and 100kN at 5m and 10m from the right end respectively. Determine the Horizontal Thrust and Bending Moment under 160kN load. **05**

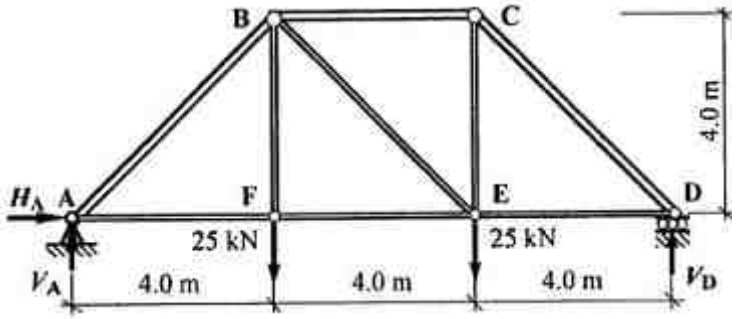
(b) The portal frame ABCD is loaded and supported as shown below. Use **flexibility method** for analysis, draw the bending moment diagram. Consider EI = Constant. **15**




**Q.6** (a) Analyse the continuous beam by Clapeyron's Theorem. Draw the bending moment diagram. Consider I to be constant throughout the beam. **08**




(b) Find the vertical deflection at F ($\Delta_{VF}$) using unit load method. AE = Constant. **12**

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**Time: 3 Hours** **Total marks: 80**

NOTE:
i) Question No. 1 is compulsory.
ii) Attempt any three out of the remaining five questions.
iii) Figure to the right indicates full marks.
iv) Assume suitable data if required.

Q.1 Write notes on **any four** of the following questions. **20**

i.- Differentiate Prismatic and Surveyor compass
ii.- Characteristics of contour lines
iii.- Radial contouring.
iv.- Types of curves.
v.- Zero circle.

Q.2 A) The following consecutive readings were taken with a level and 4m levelling staff on a continuously sloping ground at common intervals of 30m. **10**
0.905(on A), 1.745, 2.345, 3.125, 3.725, 0.545, 1.390, 2.055, 2.955, 3.455, 0.595, 1.015,1.850, 2.655 and 2.945(on B)
The RL of A was 395.500. Calculate the RLs of different points and find the gradient of the line AB.

B) What are the difficulties faced in levelling? Explain. **10**

Q.3 A) An incomplete traverse stable is given below **10**

| Line | Length(m) | Bearing |
|---|---|---|
| AB | 100.0 | ? |
| BC | 80.5 | $140^0$ 30’ |
| CD | 60.0 | $220^0$ 30’ |
| DA | ? | $310^0$ 15’ |

Calculate the length of DA and bearing of AB.

B). Explain the working procedure of repetition and reiteration methods. **10**

Q.4 A) A tacheometer fitted with an analytic lens and having a multiplying constant of 100 was set up at R, which is an intermediate point on a traverse leg AB. The following reading were taken with the staff held vertically. **10**

| Staff station | Bearing | Vertical angle | Intercept (m) | Axial hair reading(m) |
|---|---|---|---|---|
| A | $40^0$ 35’ | $-4^0$ 24’ | 2.21 | 1.99 |
| B | $22^0$ 35’ | $-5^0$ 12’ | 2.02 | 1.90 |

Calculate the length AB and the level difference between A and B

B) Explain the principle and applications of EDM. **10**

Q.5 A) the following perpendicular offsets were taken from a chain line to a hedge **10**

| Distance (m) | 0 | 5 | 10 | 15 | 20 | 30 | 40 | 50 | 65 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| Offset(m) | 3.40 | 4.25 | 2.60 | 3.70 | 2.90 | 1.80 | 3.20 | 4.50 | 3.70 | 2.80 |

Calculate the area by Trapezoidal rule and Simpson's rule.

B) Explain the principle of Plane table surveying. Discuss about its merits and demerits? **10**

Q.6 A) two straight lines AC and CB to be connected by a 3 deg curve, intersect at a chainage of 2,760 m. the WCBs of AC and CB are $45^0 30'$ and $75^0 30'$ respectively. Calculate all necessary data for setting out the curve by method of offsets from the long chord **10**

B) What is bearing? Describe the types bearing with necessary diagram. **5**

C) What is ranging? Explain the types of ranging. **5**

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