(b) sight distance
(c) Super elevation
(d) Impact factor

40. What is the coeff of hardness in dorry abration test of loss of weight in 19 grams?
(a) 19 (b) 20
(c) 6.3 (d) 13.7

41. A plate load test conducted with 75cm diameter plate on soil sub grade yielded deflection of 2.5 mm under a stress of 800 N/cm^2. The modules of elasticity of sub grade soil in kN/cm^2 is
(a) 141.6 (b) 154.6
(c) 160 (d) 185.4

42. Benkelman beam deflection method is used for
(a) Rigid overlay on riqid pavement
(b) Rigid overlay on flexible pavement
(c) flexible overlay on rigid pavement
(d) flexible overlay on flexible pavement

43. In CBR test, standard load value for 2.5 mm penetration is
(a) 2055 kg (b) 105 kg
(c) 70 kg (d) 1370 kg

44. Resistance to abration is called
(a) Hardness (b) Toughness
(c) CBR (d) Impact strength

45. IRC recommendation for value of flakiness index is
(a) $\nearrow 10\%$ (b) $\nearrow 5\%$
(c) $\nearrow 15\%$ (d) $\nearrow 20\%$

46. Ring and ball test apparatus is used to measure
(a) Viscosity (b) softening point
(c) consistency (d) durability

47. A two lane single carriage way is to be designed for a design life of 15 year. Total two way traffic intensity in the year completion of construction is expected to be 2000 commercial vehicle per day. The vehicle damage factor is 3.0, lane distribution factor = 0.75. Assuming an annual rate of 7.5%, the design traffic expressed as commutative number of standard angles, is
(a) 42.9×10^6 (b) 22.6×10^6
(c) 10.1×10^6 (d) 5.3×10^6

48. What is the specific gravity range of pure bitumen?
(a) 0.97 to 1.02 (b) 0.81 to 0.97
(c) 1.10 to 1.25 (d) 0.97 to 1.10

49. For what approx value of tyre pressure, rigidity factor unity is?
(a) 6 kg/cm^2 (b) 7 kg/cm^2
(c) 8 kg/cm^2 (d) 7.5 kg/cm^2

50. Bituminous concrete is a mix comprising of
(a) Fine aggregate, filler and bitumen
(b) Fine aggregate and bitumen
(c) Coarse aggregate, fire aggregate and bitumen
(d) Coarse aggregate, filler and bitumen

ANSWER KEY																			
1	(b)	6	(d)	11	(d)	16	(c)	21	(c)	26	(a)	31	(b)	36	(c)	41	(a)	46	(b)
2	(d)	7	(c)	12	(c)	17	(a)	22	(a)	27	(b)	32	(b)	37	(b)	42	(d)	47	(a)
3	(c)	8	(b)	13	(b)	18	(b)	23	(a)	28	(c)	33	(b)	38	(c)	43	(d)	48	(a)
4	(a)	9	(a)	14	(a)	19	(b)	24	(b)	29	(a)	34	(c)	39	(b)	44	(a)	49	(b)
5	(c)	10	(c)	15	(d)	20	(b)	25	(b)	30	(d)	35	(b)	40	(d)	45	(c)	50	(c)

HINTS & EXPLANATIONS

1. (b) Lag distance $= 60 \times \frac{5}{18} \times 2.5 = 41.67$ m

$$\frac{\text{Lag distance}}{\text{Brake distance}} = \frac{6}{5}$$

$\therefore$ Brake distance(s) $= 41.67 \times \frac{5}{6} = 34.725$ m

$$S = \frac{v^2}{2gf + g\sin\theta}$$

$$\therefore \quad 2f + \sin\theta = \frac{v^2}{Sg}$$

$$\therefore \quad \sin\theta = \frac{v^2}{Sg} - 2f$$

$$= \frac{16.672}{34.75 \times 9.81} - 2 \times 0.36 = 34.75$$

$\therefore \quad \theta = 4.8\%$

3. (c) Extra widening $= \frac{nL^2}{2R} + \frac{V}{9.5\sqrt{R}}$

$$= \frac{2 \times 8^2}{2 \times 300} + \frac{100}{9.5\sqrt{300}} = 0.82 \text{ m}$$

4. (a) Compensation for ruling gradient $= \frac{30 + R}{R} = 1.6\%$

Max. value $= \frac{75}{R} = 1.5\%$

$\therefore$ Take 1.5%

But as per question, take 1.6%

$\therefore$ Compensated gradient $= 6 - 1.6 = 4.4\%$

5. (c) SSD $= vt + \frac{v^2}{2g}$

$$v = 60 \times \frac{5}{18} = 16.67 \text{ m/s}$$

$$\text{SSD} = 16.67 \times 2.5 + \frac{16.67^2}{2 \times 9.81 \times 0.35}$$

$$= 82.134 \text{ m}$$

For 2 way traffic, SSD′ $= 2 \times$ SSD $= 164.27$ m

10. (c) Off tracking means mechanical widening, i.e. $\frac{nL^2}{2R}$

$$0.096 = \frac{n\ell^2}{2R} = \frac{6.6^2}{2R}$$

$\therefore \quad R = 226.87$ m

Psychological widening $= \frac{V}{9.5\sqrt{R}} = \frac{80}{9.5\sqrt{226.87}}$

$= 0.56$ m

Total widening $= 0.56 + 2 \times 0.096 = 0.75$ m

11. (d) Probability of k vehicles arrival,

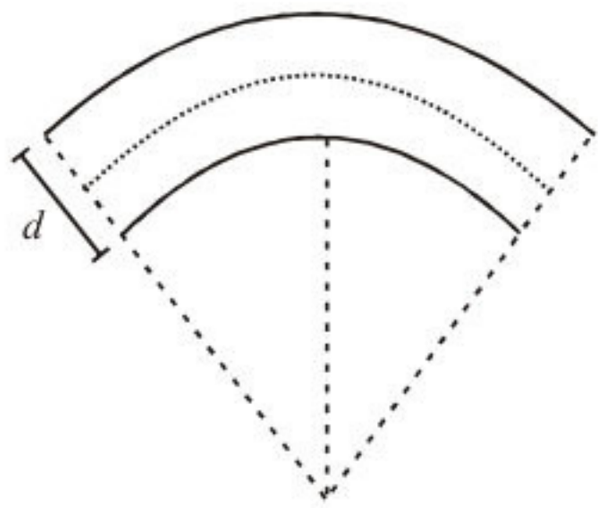
$$P(k) = \frac{(\lambda t)^k e^{-\lambda t}}{k!}$$

Time headway $\geq t_1$ means no vehicle arrives

i.e., $k = 0$

$\therefore \quad P(k) = e^{-\lambda t_1}$

14. (a)



$$Q = \left(\frac{SSD}{R + 7.5}\right) \times \frac{180}{\pi} = \frac{80}{(300 + 7.5)} \times \frac{180}{\pi} = 14.9°$$

$$S = \left(R + \frac{d}{4}\right)\left(1 - \cos\frac{\theta}{2}\right) = 2.54 \text{m}$$

15. (d) $L = \frac{v^3}{JR}$

Jerk, J is the rate of change of acceleration.

19. (b) $\text{SSD} = \text{vt} + \frac{\text{v}^2}{2\text{gf}} (\text{m/s})$

$$= .278vt + \frac{v^2}{254 \times f} (kmph)$$

$$= .278 \times 50 \times 2 + \frac{50^2}{254 \times .36} = 55.14 \text{ m}$$

$\therefore$ It is single lane road, SSD′ $= 2 \times$ SSD

$= 2 \times 55.14 = 110.28$

21. (c) $\text{SSD} = \frac{\text{v}^2}{2\text{gf}} = \frac{v^2}{254f} (kmph)$

$$76.5 = \frac{80^2}{254 \times f} \qquad \therefore f = 0.33$$

22. (a) $SSD = .278Vt + \frac{V^2}{254f}$

$= .278 \times 50 \times 2.5 + \frac{50^2}{254 \times 0.37}$ $(Assume\ \ t = 2.55)$

$= 61.3m$

23. (a) $SSD = 0.278Vt + \frac{V^2}{254(f + .01n)}$

$= .278 \times 60 \times 2.5 + \frac{60^2}{254(.35 + .05)} = 77.13\text{m}$

24. (b) ISD=2 × SSD= 2 × 61.3=122.6m (Qn 7)

25. (b) $SSD = 0.278Vt + \frac{V^2}{(f + 0.01N)}$

$= 0.278 \times 72 \times 1.5 + \frac{72^2}{254(0.15 + 0.02)} = 150\text{ m}$

26. (a) $OSD = V_B t + V_B T + 2S + VT$

$S = 0.2V_B + 6 = 0.2 \times 40 + 6 = 14$

$T = \sqrt{\frac{4S}{a}} = \sqrt{\frac{4 \times 14}{0.9}} = 7.89\text{s}$

$V_B = V - 16$

$\therefore V = V_B + 16 = 40 + 16 = 56\,\text{kmph}$

$\therefore OSD = (40 \times 2 + 40 \times 7.89 + 56 \times 7.89) \times 0.278 + 2 \times 14$

$= 260.8 \approx 261m$

27. (b) $V_B = V - 16 = 100 - 16 = 84kmph$

$S = 0.2V_B + 6 = 22.8m$

$T = \sqrt{\frac{4S}{a}} = 13.12s$

$OSD = 0.278(V_B t + V_B T + VT) + 2s$

$= 0.278(89 \times 2 + 84 \times 13.12 + 100 \times 13.12) + 2 \times 22.8$

$\approx 750m$

29. (a) $e + f = \frac{V^2}{127R}$

$e + 0.13 = \frac{60^2}{127 \times 120}$ $\therefore e = 0.11$

30. (d) When pressure in inner and outer wheels should be equal, f = 0

$\therefore e = \frac{V^2}{127R} = 0.26$

31. (b) $e + f = \frac{V^2}{127R}$

$0.07 + f = \frac{100^2}{127 \times 400}$

$f = 0.126 \approx 0.13$

32. (b) $W_m = \frac{nl^2}{2R} = \frac{2 \times 8^2}{2 \times 3100} = 0.206$

33. (b) $W_m = \frac{l_2}{2R}$

$0.09 = \frac{6.8^2}{2 \times R}$

$\therefore R = 257m$

$W_e = \frac{nl^2}{2R} + \frac{V}{9.5\sqrt{R}}$

$= \frac{2 \times 6.8^2}{2 \times 257} + \frac{65}{9.5\sqrt{257}}$

$= 0.1799 + 0.4207 = 0.6006$

34. (c) $Shift = \frac{L_s^2}{24R} = \frac{56^2}{24 \times 280} = 0.46$

35. (b) $d = \frac{8}{4} = 2m$

$\alpha = \frac{S}{R - d} \times \frac{180}{\pi}$

$= \frac{75}{300 - 2} \times \frac{180}{\pi} = 14.42°$

$m = R - (R - d)\cos\frac{\alpha}{2}$

$= 300 - (300 - 2)\cos\frac{14.42}{2} = 4.36m$

Set back distance from inner lane= 4.36 –2 =2.26m

38. (c) $L = \frac{NS^2}{\left(\sqrt{2H} + \sqrt{2h}\right)^2}$

$= \frac{0.09 \times 120^2}{\left(\sqrt{2 \times 1.5} + \sqrt{2 \times 0.15}\right)^2} = \frac{1296}{(1.73 + 0.55)^2} \approx 250m$

40. (d) Coeff of hardness

$= 20 - \frac{Loss\ of\ weight}{3} = 20 - \frac{19}{3} = 13.7$

41. (a) $E = \frac{1.18Pa}{8} = \frac{1.18 \times 800 \times (75/2)}{0.25}$

$= 141.6kN/cm^2$

47. (a) $N = \frac{365\left((1 + r)^n - 1\right)A.D.F}{r}$

$= \frac{365\left[(1 + .075)^{15} - 1\right] \times 2000 \times 0.75 \times 3}{0.075}$

$= 42.9$ msa

TRAFFIC ENGINEERING

TRAFFIC CHARACTERISTICS

(i) **Road user (driver) characteristics:** Physical, emotional, mental characteristics and experience affect the vehicle usage.

(ii) **Vehicle characteristics:**

(a) **Static characteristics:** Dimension, weight, design and turning angle.

(b) **Dynamic characteristics:** Speed, acceleration, braking characteristics.

EFFECT OF DIMENSION OF VEHICLE

(i) **Width of vehicle:** It affects the width of lanes, shoulders of parking area.

(ii) **Length of vehicle:** It affects OSD, capacity of road, parking facilities.

(iii) **Height of vehicle:** It affects clearance under overbridges, underbridges, electric lines.

TRAFFIC STUDY

(i) **Traffic volume study:** It is the number of vehicles crossing a section of road per unit time. It is expressed as vehicles/hour or vehicles/day depending upon the type of traffic.

Design hourly volume or 30th highest hourly volume: It is the hourly volume that will be exceeded only 29 times a year. This value is usually taken as hourly volume for design purposes.

(ii) **Speed study:**

(a) **Spot speed:** It is the instantaneous speed of vehicle at a specified location.

(b) **Running speed:** Average speed of a vehicle in a given distance.

(c) **Overall speed or Travel speed:** It is the effective speed of a vehicle travelling a particular distance. This can be defined in two ways.

- **Space Mean Speed:** Average speed of all vehicles in a given stretch of highway under specific time.

$$V_S = \frac{3.6\,d\,n}{\sum_{i=1}^{n} t_i}$$

$d \rightarrow$ length of road considered

$n \rightarrow$ number of vehicles

$t \rightarrow$ travel time

- **Time Mean Speed:** Average speed of all vehicles passing a point over a specific duration. It is average of spot speed.

$$V_t = \frac{\sum_{i=1}^{n} V_i}{n}$$

$V_i \rightarrow$ observed instantaneous speed (or spot speed)

Spot Speed Study: Spot speed is usually measured by enoscope. Other commonly used instruments are electronic meter, photoelectric meter, pressure contact strips, radar speed meter, time lapse method.

Upper speed limit (safe speed limit) = 85th percentile speed

Lower speed limit = 15th percentile speed.

Speed used for geometric design = 98th percentile speed.

(iii) **Origin destination study (OD study):** It shows the amount of traffic existing between various locations.

Methods of OD data survey:

(a) Roadside interview method

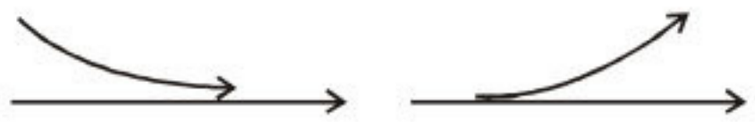
(b) License plate method

(c) Jag on vehicle

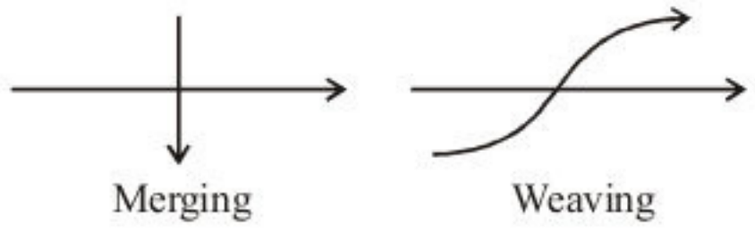
(d) Postcard method

(e) Home interview method

OD Study data is presented in the form of desire lines. These are lines that connect origin and destination. The width of desire lines shows the density of traffic in that route.



Merging Diverging



Merging Weaving

(iv) **Traffic flow characteristics:** Diverging, merging and crossing are the basic traffic flow manoeuvres. Traffic manoeuvre curves are used to represent these:

(v) **Traffic Capacity Study:**

(a) **Traffic volume (Traffic flow):** It is the number of vehicles moving in a specified direction in a day.

(b) **Traffic density:** It is the number of vehicles occupying a given length of traffic lane at given instant.

Traffic volume = traffic density × speed

(c) **Traffic capacity (*C*):** It is the ability of a roadway to accommodate traffic volume. It is expressed in vehicles/hour/lane.

(d) **Time headway (H_t):** Time gap between two successive vehicles to cross a section of roadway.

$$\text{Capacity, } C = \frac{3600}{H_t}$$

(e) **Distance headway:** It is the inverse of traffic density.

(f) **Basic capacity (Ideal capacity):** It is the maximum no. of vehicles that pass a given point on a lane or roadway during one hour under most ideal conditions.

(g) **Practical capacity (design capacity):** It is the maximum no. of vehicles that pass a given point on a lane during one hour under normal conditions without unreasonable delay.

$$\text{Basic capacity, } C = \frac{1000V}{S}$$

$V \rightarrow$ speed of vehicle (kmph)

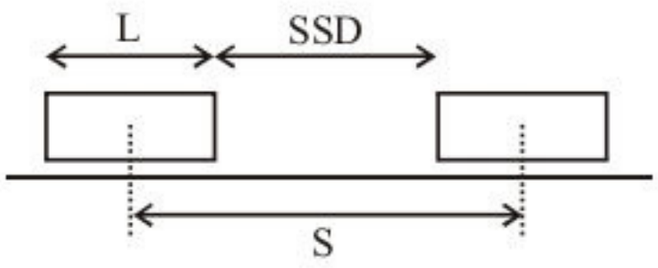
$S \rightarrow$ centre to centre spacing of vehicle

$= \text{SSD} + \text{length of vehicle} = 0.278Vt + L$

$t \rightarrow$ avg. reaction time (0.7 seconds),

$$C = \frac{3600}{H_t}$$

$H_t \rightarrow$ minimum time headway



PASSENGER CAR UNITS (PCUs)

PCU is the measure of space requirement for a vehicle compared to that of a passenger car under standard conditions. It represents how many passenger cars must be there in the place of that vehicle so that the effect produced on the traffic condition by that vehicle is the same.

Vehicle Class	PSU
Passenger car, autorickshaw, tractor	1.0
Motorcycle, scooter, cycle	0.5
Cycle rickshaw	1.5
Bus, truck	3.0
Horse drawn vehicle	4.0
Large bullockcart	8.0

CAPACITY FLOW

Maximum flow $q_{\max.}$ occurs when speed is $\frac{V_{sf}}{2}$ and density is $\frac{K_j}{2}$.

$$q_{\max} = \frac{V_{sf} \times K_j}{4}$$

V_{sf} = max. speed (free mean speed)

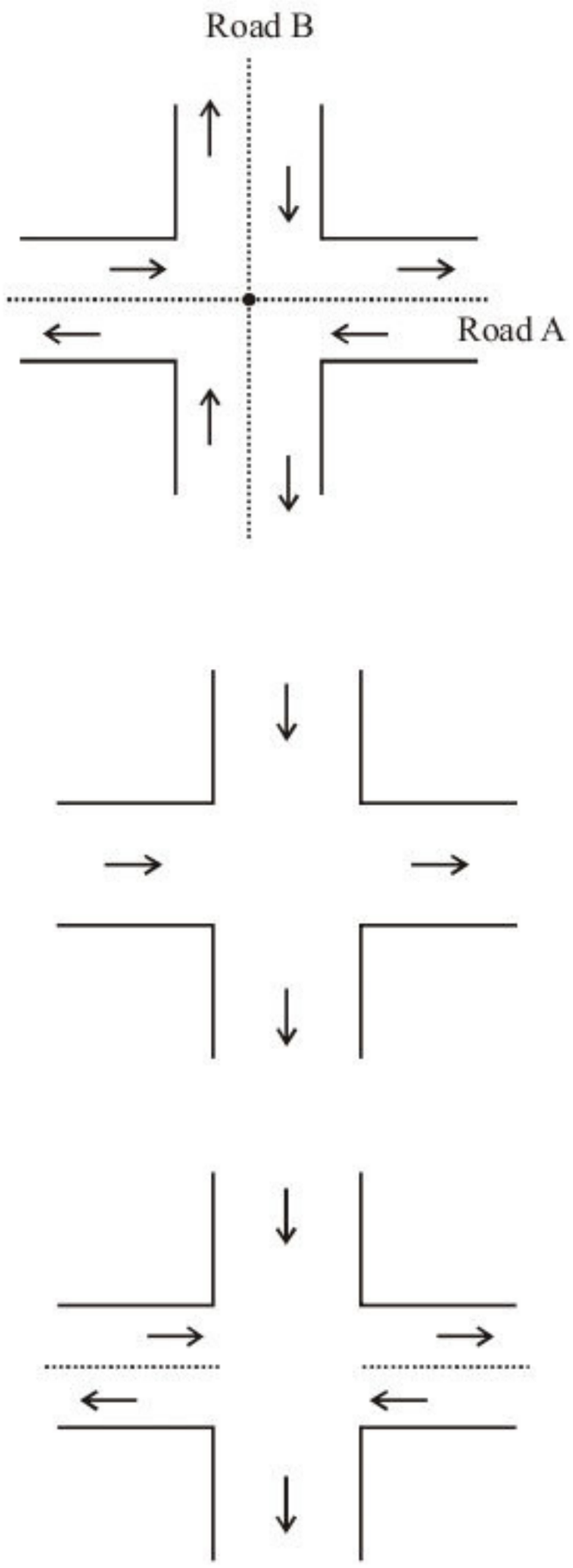
K_j = jam density

CONFLICT POINTS AT AN INTERSECTION

(1) **Both roads 2 way :** Conflict points = 24

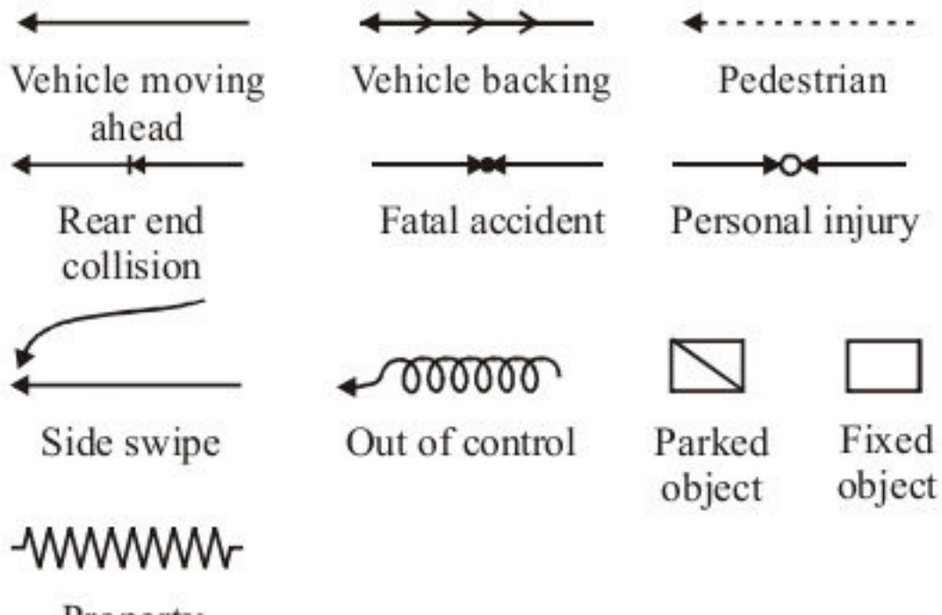
(2) **Both roads 1 way :** Conflict points = 6

(3) **One road 1 way :** Conflict points = 11



ACCIDENT STUDY

Collision diagram:



3 E's in reduction of accident rates
Engineering, Enforcement, Education

PARKING STUDY

Parking can be of 2 types: On street parking (kerb parking), Off street parking.

90° parking is most efficient for space constraint area.

Aspects in parking study: Parking demand, parking space, parking characteristics.

ROTARY INTERSECTION

1. **Radius of rotary:**

$$R = \frac{V^2}{127(e+f)} = \frac{V^2}{127f} \text{ (equation of super elevation)}$$

Here we take, $e = 0$ and $f = 0.43$ and 0.47 for speeds 40 and 30 kmph.

2. **Weaving angle:** Angle between path of vehicle leaving the rotary and path of vehicle entering the rotary. It should be $\geq 15°$.

3. **Width of rotary roadway:**

$$w = \left[\frac{e_1 + e_2}{2}\right] + 3.5$$

$e_1 \rightarrow$ average width at entry

$e_2 \rightarrow$ average width at non-weaving section

4. **Capacity of rotary roadway:**

$$Q_p = \frac{280w\left(1+\frac{e}{w}\right)\left(1-\frac{P}{3}\right)}{\left(1+\frac{w}{\ell}\right)}$$

$w \rightarrow$ width of weaving section (6-18 m)

$e \rightarrow \frac{e_1 + e_2}{2}$

$\ell \rightarrow$ weaving length

P – proportion of weaving traffic $= \frac{b+c}{a+b+c+d}$

$b \rightarrow$ weaving traffic turning right while entering the rotary

$c \rightarrow$ weaving traffic turning left while leaving the rotary

$a \rightarrow$ left turning traffic moving along left extreme lane.

$d \rightarrow$ right turning traffic moving along right extreme lane.

TRAFFIC SIGNS

Traffic signs are of two types:

(a) **Regulatory signs (Mandatory signs):** Used to inform road users about certain rules, laws or prohibitions for safe and free traffic.

Eg. Stop, no left turn, one way, no overtaking, no parking etc.

(b) **Warning signs:** Used to warn road users about some hazardous conditions.

Eg. Junction, U-turn, sharp bend, school zone etc.

(c) **Informatory signs:** Used to guide road users.

Eg. Route marking, distance to junction.

(d) **Design of signals:**

Optimum signal time, $Co = \frac{1.5L + 5}{1 - Y}$

L $\rightarrow$ lost time in second, $L = 2n + R$

$n \rightarrow$ no. of phases; $R \rightarrow$ all red time.

$Y = y_1 + y_2 + y_3$

EXERCISE

1. Name the traffic survey data which is plotted by means of "Desire lines".
(a) Accident
(b) Classified volume
(c) Origin and Destination
(d) Speed and Delay

2. On an urban road, the free mean speed was measured as 70 kmph and the average spacing between the vehicles under jam condition as 7.0 m. The speed-flow-density equation is given by

$$U = U_{sf}\left[1-\frac{k}{k_1}\right] \text{ and } q = UK$$

where, $U \rightarrow$ space-mean speed (kmph); $U_{sf} \rightarrow$ free mean speed (kmph); $k \rightarrow$ density (veh/km); $k_j \rightarrow$ jam density (veh/km); $q \rightarrow$ flow (veh/hr). The maximum flow (veh/hr) per lane for this condition is equal to
(a) 2000 (b) 2500
(c) 3000 (d) None of these

3. If a two-lane national highway and a two-lane state highway intersect at right angles, the number of potential conflict points at the intersection, assuming that both the roads are two-way is
(a) 11 (b) 17
(c) 24 (d) 32

4. In signal design as per Indian Roads Congress specifications, if the sum of the ratios of normal flows to saturation flow of two directional traffic flow is 0.50 and the total lost time per cycle is 10 seconds, the optimum cycle length in seconds is
(a) 100 (b) 80
(c) 60 (d) 40

5. If the standard deviation of the spot speed of vehicles in a highway is 8.8 kmph and the mean speed of the vehicles is 33 kmph, the coefficient of variation in speed is
(a) 0.1517 (b) 0.1867
(c) 0.2666 (d) 0.3646

6. The capacities of "One-way 1.5 m wide sidewalk (persons per hour)" and "One-way 2-lane urban road (PCU per hour, with no frontage access, no standing vehicles and very little cross traffic) are respectively
(a) 1200 and 2400 (b) 1800 and 2000
(c) 1200 and 1500 (d) 2000 and 1200

7. The shape of the STOP sign according to IRC: 67-2001 is
(a) circular (b) triangular
(c) octagonal (d) rectangular

8. A roundabout is provided with an average entry width of 8.4 m, width of weaving section as 14 m and length of the weaving section between channelizing islands as 35 m. The crossing traffic and total traffic on the weaving section are 1000 and 2000 PCU per hour respectively. The nearest rounded capacity of the roundabout (in PCU per hour is)
(a) 3300 (b) 3700
(c) 4500 (d) 5200

9. It is proposed to widen and strengthen an existing 2-lane NH section as a divided highway. The existing traffic in one direction is 2500 commercial vehicles (CV) per day. The construction will take 1 year. The design CBR of soil subgrade is found to be 4 percent. Given: traffic growth rate for CV = 8 percent, vehicle damage factor = 3.5 (standard axles per CV), design life = 10 years and traffic distribution factor = 0.75. The cumulative standard axles (msa) computed are
(a) 35 (b) 37
(c) 65 (d) 70

10. A linear relationship is observed between speed and density on a certain section of a highway. The free flow speed is observed to be 80 km per hour and the jam density is estimated as 100 vehicles per km length. Based on the above relationship, the maximum flow expected on this section and the speed at the maximum flow will respectively be
(a) 8000 vehicles per hour and 80 km per hour
(b) 8000 vehicles per hour and 25 km per hour
(c) 2000 vehicles per hour and 80 km per hour
(d) 2000 vehicles per hour and 40 km per hour

11. As per IRC: 67-2001, a traffic sign indicating the Speed Limit on a road should be of
(a) Circular Shape with White Background and Red Border
(b) Triangular Shape with White Background and Red Border
(c) Triangular Shape with Red Background and White Border
(d) Circular Shape with Red Background and White Border

12. The cumulative arrival and departure curve of one cycle of an approach lane of a signalized intersection is shown in the adjoining figure. The cycle time is 50 s and the effective red time is 30 s and the effective green time is 20 s. What is the average delay?
(a) 15 s (b) 25 s
(c) 35 s (d) 45 s

13. If the jam density is given as k_j and the free flow speed is given as u_f, the maximum flow for a linear traffic speed-density model is given by which of the following options?
(a) $\frac{1}{4}k_j \times u_f$ (b) $\frac{1}{3}k_j \times u_f$
(c) $\frac{3}{5}k_j \times u_f$ (d) $\frac{2}{3}k_j \times u_f$

14. Two major roads with two lanes each are crossing in an urban area to form an uncontrolled intersection. The number of conflict points when both roads are one-way is "X" and when both roads are two-way is "Y". The ratio of X to Y is

(a) 0.25 (b) 0.33

(c) 0.50 (d) 0.75

15. A two-lane urban road with one-way traffic has a maximum capacity of 1800 vehicles/hour. Under the jam condition, the average length occupied by the vehicles is 5.0 m. The speed versus density relationship is linear. For a traffic volume of 1000 vehicles/hour, the density (in vehicles/km) is

(a) 52 (b) 58

(c) 67 (d) 75

16. The road geometrics in India are designed for

(a) 98th highest hourly traffic volume

(b) 85th highest hourly traffic volume

(c) 50th highest hourly traffic volume

(d) 30th highest hourly traffic volume

17. On an urban road, the free mean speed was measured as 70kmph and the average spacing between the vehicles under jam condition as 7m. the speed flow density equation is given by $U = Usf\left\{1-\frac{k}{kg}\right\}$ and $q = Uk$ Where,

u = space mean speed (kmph); Usf = free mean speed(kmph); k = density(veh/km); kj – jam density(veh/km)

q = flow(veh/hr). The maximum flow(veh/hr). the maximum flow(veh/hr) per lane for this condition is equal to

(a) 2000 (b) 2500

(c) 3000 (d) none of these

18. A transport company operates a scheduled daily truck service between city P and Q. The one way journey between these two cities is 85 hours. The minimum layover time of 5 hours is to be provided for this service is?

(a) 4 (b) 6

(c) 7 (d) 8

19. What is the number of conflict points in an 2 road interaction when both roads are two way.

(a) 6 (b) 12

(c) 24 (d) 36

20. A single lane unidirectional highway has a design speed of 65 kmph. The perception-brake-reaction time of driver is 2.5 seconds and the average length of vehicle is 5 m. The coeff of longitudinal friction of the pavement is 0.4. The capacity of this road in terms of veh/hour/lane is

(a) 1440 (b) 750

(c) 710 (d) 680

21. If in a Dorry abrasion test, loss in weight is 27 gms, then coefficient of hardness will be

(a) 11 (b) 12

(c) 13 (d) 14

22. Stopping sight distance depends upon

(a) total reaction time of driver

(b) speed of vehicle

(c) efficiency of brakes

(d) all of these

23. When path travelled along the road surface is more than the circumferential movement of the wheels due to rotation, then it results in

(a) slipping (b) skidding

(c) turning (d) revolving

24. In which of the following traffic signal systems, cycle length and cycle division automatically varied?

(a) Simultaneous system

(b) Alternate system

(c) Simple progressive system

(d) Flexible progressive system

25. Drive ways are

(a) road connecting highways with commercial establishments like fuel stations.

(b) provided near public the conveniences with guide maps

(c) provided along the roads to serve as an emergency lane for vehicle compelled to be taken out of the road way

(d) also called expressways

26. Which of the following pair is not correctly matched?

Vehicle class		**Equivalentry Factors (PCU)**
(a) Passenger car, tampo	–	1
(b) Bus, Truck	–	3
(c) Two wheeler automobile	–	0.5
(d) Small bullock cart	–	4

27. On a highway if velocity of moving vehicle is 60 kmph, stopping distance is 25 meters and average length of a vehicle be 5 metre, then basic capacity of the lane will be

(a) 2000 veh/sec (b) 1500 veh/sec

(c) 3000 veh/sec (d) 3200 veh/sec

28. Traffic conflicts that may occur in a rotary inter-section are

(a) merging and diverging

(b) crossing and merging

(c) crossing and diverging

(d) crossing, merging and diverging

29. Gravity model is used in transportation planning process for

(a) model split (b) trip distribution

(c) trip generation (d) trip assignment

30. In desire line diagram

(a) width of desire line is proportional to the number of trips in one directions

(b) length of desire line is proportional to the number of trips in both direction

(c) width of desire line is proportional to the number of trips in both directions

(d) both length and width of desire line one proportional to the number of trips in both directions

31. A traffic rotary is justified where

(a) number of interesting roads is between 4 and 7

(b) space is limited and costly

(c) when traffic volume is less than 500 vehicles per hour

(d) when traffic volume is more than 5000 vehicles per hour

32. Maximum number of vehicles can be parked with

(a) parallel parking (b) 30° angle parking

(c) 45° angle parking (d) 90° angle parking

33. The entrance and exit curves of a rotary have

(a) equal radii and equal width of pavement

(b) equal radii but pavement width is more at entrance than at exit curve

(c) equal pavement widths but radius is more at entrance curve than at exit curve

(d) different radii and different widths of pavements

34. As per IRC-recommendations, average level of illumination on important roads carrying fast traffic is

(a) 10 lux (b) 15 lux

(c) 20 lux (d) 30 lux

35. A rotary will be more suitable than control by signals in situations listed against

(a) traffic volume entering from all roads is less than 300 vehicle per hour

(b) a road is in a hilly region

(c) both (a) and (b)

(d) none of these

36. Conflict which may occur in a rotary inter-section is

(a) merging and diverging

(b) crossing and merging

(c) crossing merging and diverging

(d) crossing and diverging

ANSWER KEY															
1	(c)	6	(a)	11	(a)	16	(d)	21	(a)	26	(d)	31	(a)	36	(a)
2	(b)	7	(c)	12	(a)	17	(b)	22	(d)	27	(a)	32	(d)		
3	(c)	8	(b)	13	(a)	18	(d)	23	(b)	28	(a)	33	(d)		
4	(d)	9	(d)	14	(a)	19	(c)	24	(d)	29	(b)	34	(d)		
5	(c)	10	(d)	15	(c)	20	(c)	25	(a)	30	(c)	35	(c)		

HINTS & EXPLANATIONS

2. (b) $u = u_{sf}\left[1-\frac{k}{k_j}\right]$

$q = uk$

$\frac{q}{k} = u_{sf}\left[1-\frac{k}{k_j}\right] \Rightarrow q = u_{sf}\left[1-\frac{k}{k_j}\right]k$

Diff. w.r.t.k,

$\frac{dq}{dk} = 0 \Rightarrow u_{sf}\left[1-\frac{2k}{k_j}\right] = 0$

$\Rightarrow \quad k = \frac{k_j}{2}$

$\therefore \quad q_{\max} = u_{sf} = \left[1-\frac{1}{2}\right]\times\frac{k_j}{2} = u_{sf}\times\frac{k_j}{4}$

$= 70\times\frac{1000}{7\times4} = 2500$

3. (c) No. of conflict points in 2 way 2 lane = 24

4. (d) Optimum cycle length $= \frac{1.5L+5}{1-4}$

$= \frac{1.5\times10+5}{1-0.5} = 40s$

5. (c) C.V $= \frac{5}{x}$

6. (a) 1 way side walk – 1200 persons/hour

1 way 2 lane side walk – 2400 persons/hour

8. (b) Proportion of weaving traffic $= \frac{1000}{2000} = 0.5$

Capacity, $Q_P = \frac{280w\left(1+\frac{e}{w}\right)(1-P/3)}{(1+w/L)}$

$= \frac{280\times14\left(1+\frac{8.4}{14}\right)\left(\frac{1-0.5}{3}\right)}{1+\frac{14}{35}}$

$= 3733.3 \approx 3700$ pcu

9. (d) Cumulative axle load, (CSA)

$N_s = \frac{365A\left[(1+r)^n-1\right]}{r}\times F$

$= \frac{365\times3750\times\left[\left(1+\frac{8}{100}\right)^{10}-1\right]}{8/100}\times3.5 \approx 70$ msa

10. (d) $q_{\max} = \frac{\text{Free flow speed}\times\text{Jam density}}{4}$

$= \frac{80\times100}{4} = 2000$ vehicles/hour

Speed (At q_{max}) $= \frac{\text{Free flow speed}}{2}$

$= \frac{80}{2} = 40$ kmph

12. (a) In SOS cycle, delay is by red signal.

$\therefore \quad$ Avg. delay $= \frac{\text{red light time}}{2} = \frac{30}{2} = 15$s

13. (a) For max. flow, $k = \frac{k_j}{2}$

$u = \frac{u_f}{2}$

$q = k\times u$

$q_{max} = \frac{kj}{2}\times\frac{u_j}{2} = \frac{1}{4}.k_j.u_j$

14. (a) Conflict points:

Both roads one way – 6 (x)

Both roads two way – 24 (y)

$x/y = 6/24 = 0.25$

15. (c) $q_{\max.} = \dfrac{k_j . u_j}{4}$

$$\therefore \quad k_j = \frac{4 q_{\max.}}{4 j} = \frac{4 \times 1800}{18} = 400 \text{ veh./km}$$

$$q = k.v = k\left[u_f\left(1 - \frac{k}{k_j}\right)\right]$$

$$1000 = k\left[18\left(1 - \frac{k}{400}\right)\right]$$

$$\therefore \quad \text{k} = 66.6 \approx 67.$$

17. (b) $K_m = \dfrac{1000}{5} = \dfrac{1000}{7} = 142 veh/km$

$$C = \left(\frac{K_m}{2}\right)\left(\frac{V_m}{2}\right) = \frac{142 \times 70}{4}$$

$$= 2500 veh/hr/lane$$

18. (d) Total journey $= 85 + 85 + 5 = 175$ hours

$$\text{No of vehicles} = \frac{175}{24} \approx 8m$$

27. (a) Here, S = 25 + 5 = 30 m

$$\text{Basic capacity} = 1000 \times \left[\frac{\text{V}}{\text{S}}\right] = \frac{1000 \times 60}{30}$$

= 2000 veh/sec