CLASS TEST

S.No.:03SK_CE_JKL_21092025

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HIGHWAY

CIVIL ENGINEERING

Date of Test : 21/09/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (d)

Absolute ruling minimum radius,

$$R_{\text{ruling}} = \frac{V^2}{127(e+f)}$$

$$= \frac{(110)^2}{127 \times (0.07 + 0.15)}$$

$$= \frac{12100}{127 \times 0.22} = 433 \text{ m}$$

2. (d)

$$\text{Grade compensation} = \text{Minimum of} \begin{cases} \dfrac{30+R}{R} = \dfrac{30+60}{60} = 1.5\% \\ \dfrac{75}{R} = \dfrac{75}{60} = 1.25\% \end{cases}$$

$\therefore$ Grade compensation = 1.25%

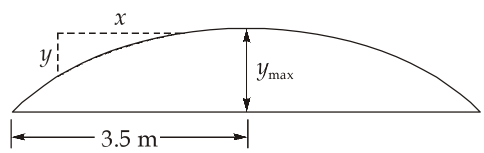
Compensated gradient = 5 – 1.25 = 3.75% but $\nless$ 4%

$\therefore$ Compensated gradient = 4%

Grade compensation allowed = 5 – 4 = 1%

3. (c)

For a two lane road without raised kerbs, width of pavement, W = 7.0 m. For bituminous concrete pavement in heavy rainfall region, provide camber of 2% i.e. 1 in 50. So, for parabolic camber,



$$y = \frac{2x^2}{WN}$$

W = 7 m

N = 50

x = 3.5 m

$$\therefore \quad y_{max} = \frac{2 \times 3.5^2}{7 \times 50}$$

$$\Rightarrow \quad y_{max} = 0.07 \text{ m} = 70 \text{ mm}$$

4. (d)

The vehicle turning on a horizontal curve with no superelevation has to fully depend on coefficient of friction. In such case, vehicle will skid if value of friction coefficient is less than $\frac{b}{2h}$ and would overturn if friction coefficient is more than $\frac{b}{2h}$.

5. (c)

$$e_{equilibrium} = \frac{V^2}{127R} = \frac{50 \times 50}{127 \times 300} = 0.066 = 6.6\%$$

6. (b)

$$SSD = 130 \text{ m}$$

$$n_1 = \frac{-1}{25} \qquad n_2 = \frac{1}{25}$$

$$N = |n_1 - n_2| = \left|\frac{-1}{25} - \left(\frac{1}{25}\right)\right| = \frac{2}{25} = 0.08$$

Assuming $L > SSD$, so

$$L = \frac{NS^2}{1.5 + 0.035S} = \frac{0.08 \times 130^2}{1.5 + 0.035 \times 130} = 223.47 \text{ m}$$

$$L > SSD \qquad \text{(OK)}$$

7. (b)

8. (b)

$$V = 50 \text{ kmph}, t = 2.0 \text{ sec}, l = 6 \text{ m}$$

Space headway, $S = 0.278\,Vt + l$

$\Rightarrow$ $S = 0.278 \times 50 \times 2 + 6$

$\Rightarrow$ $S = 33.8$ m

Theoretical capacity, $C = \frac{1000V}{S} = \frac{1000 \times 50}{33.8}$

$= 1479.29 \simeq 1480$ veh/hr

9. (a)

At edge,

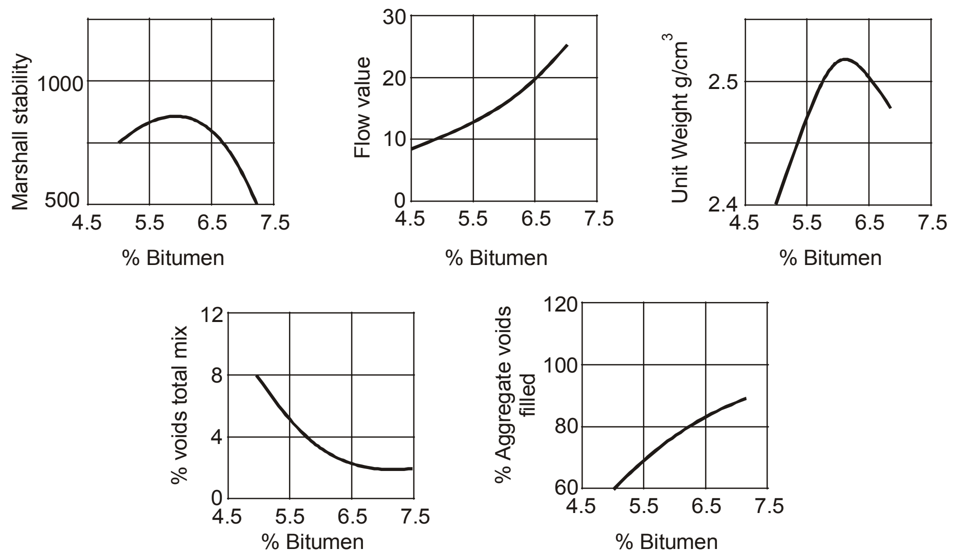
$$\text{Load stress - } \begin{cases} C \text{ at top} \\ T \text{ at bottom} \end{cases}$$

$$\text{Warping stress} \begin{cases} \text{Day} \begin{Bmatrix} C \text{ at top} \\ T \text{ at bottom} \end{Bmatrix} \\ \text{Night} \begin{Bmatrix} T \text{ at top} \\ C \text{ at bottom} \end{Bmatrix} \end{cases}$$

$$\text{Frictional stress} \begin{cases} \text{Summer} \begin{Bmatrix} C \text{ at top} \\ C \text{ at bottom} \end{Bmatrix} \\ \text{Winter} \begin{Bmatrix} T \text{ at top} \\ T \text{ at bottom} \end{Bmatrix} \end{cases}$$

So, worst condition at edge is in winter during day at the bottom of slab.

10. (b)



11. (c)

By rate of change of centrifugal acceleration

$$C = \frac{80}{75+V} = \frac{80}{75+100} = 0.457 < 0.5$$

$\therefore$ $C = 0.5$

$$L_s = \frac{0.0215V^3}{CR} = \frac{0.0215 \times (100)^3}{0.5 \times 400} = 107.5 \text{ m}$$

By rate of introduction of superelevation

$$L_s = e \times W \times N \qquad [\because \text{ rotation about inner edge}]$$

$$= 0.07 \times 7.6 \times 150$$

$$= 79.8 \text{ m}$$

By IRC formula:

For plain terrain,

Minimum length of transition curve,

$$L_s = \frac{2.7V^2}{R} = \frac{2.7 \times 100^2}{400} = 67.5 \text{ m}$$

Adopting highest of the above three values,

$$L_s = 107.5 \text{ m}$$

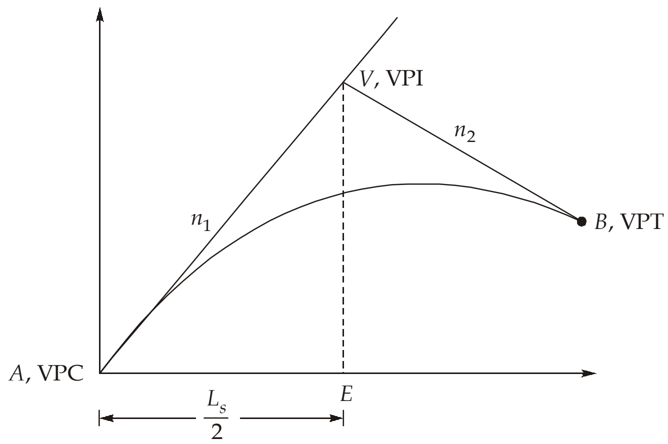
12. (d)

Assume $S < L$,

$$L = \frac{Ns^2}{\left(\sqrt{2H} + \sqrt{2h}\right)^2}$$

$N = n_1 - n_2 = 1.5 - (-0.5) = 2\%$; $H = 1.125$ m; $h = 0.1$ m

$$L = \frac{0.02 \times 300^2}{\left(\sqrt{2 \times 1.125} + \sqrt{2 \times 0.1}\right)^2} = 474.73 \text{ m} > 300 \text{ m} \qquad \therefore \text{OK}$$



$$RL_A = RL_V - \frac{L_s}{2} \times n$$

$$= 75 - \frac{474.73}{2} \times 0.015 = 71.44 \text{ m}$$

$$\text{RL of VPT (RL of } B) = RL_A + \frac{L_s}{2}(n_1 + n_2)$$

$$= 71.44 + \frac{474.73}{2}\frac{(1.5 - 0.5)}{100} = 73.81 \text{ m}$$

13. (c)

$$\text{Width of the pavement} = W + W_e$$

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

Length of wheel base = 6.1 m (as per IRC)

$$W_e = \frac{2 \times (6.1)^2}{2 \times 280} + \frac{80}{9.5\sqrt{280}} = 0.636 \text{ m} \simeq 0.64 \text{ m}$$

∴ Width of pavement = 7.0 + 0.64 = 7.64 m

Distance between centre line of highway and centre line of inner lane $= \frac{W + W_e}{4} = \frac{7.64}{4} = 1.91$ m

Given : Length of the curve = 180 m; Sight distance = 250 m

L.C < S.D

∴Set back distance from centre line of road,

$$m = R - (R - d)\cos\frac{\alpha}{2} + \left(\frac{S - L}{2}\right)\sin\frac{\alpha}{2}$$

$$L = (R - d)\alpha$$

$$\alpha = \left(\frac{180}{280 - 1.91}\right) \times \frac{180}{\pi} = 37.086°$$

$$\therefore \quad m = 280 - (280 - 1.91)\cos\left(\frac{37.086}{2}\right) + \left(\frac{250 - 180}{2}\right)\sin\left(\frac{37.086}{2}\right)$$

$$= 280 - 278.09\cos\left(\frac{37.086}{2}\right) + 35 \times \sin\left(\frac{37.086}{2}\right)$$

$= 27.48$ m

Set back distance required from outer edge of pavement = $(m + 2d)$

$= (27.48 + 2 \times 1.91) = 31.3$ m

14. (a)

$$V = 70 \text{ kmph}$$
$$f = 0.35$$
$$t = 2.5s \quad \text{(for SSD)}$$
$$\eta = 50\% = 0.5$$
$$n = -2\% = -0.02$$

$$\text{Headlight sight distance} = \text{SSD} = 0.278Vt + \frac{v^2}{254(\eta f \pm n\%)}$$

$$= 0.278 \times 70 \times 2.5 + \frac{70^2}{254(0.5 \times 0.35 - 0.02)}$$

Headlight sight distance $= 48.65 + 124.46 = 173.11$ m

Intermediate sight distance $= 2 \times \text{SSD}$

$= 2 \times 173.11 = 346.22$ m

15. (c)

$$V_b = 50 \text{ kmph}$$
$$s_1 = 20 \text{ m and } s_2 = 16 \text{ m}; \quad s = s_1 + s_2 = 36 \text{ m}$$
$$a = 0.5 \text{ m/s}^2$$
$$T = \sqrt{\frac{2(s_1 + s_2)}{a}} \Rightarrow T = \sqrt{\frac{2(20+16)}{0.5}}$$

$\Rightarrow$ $T = 12$ sec

Distance travelled by overtaking vehicle is

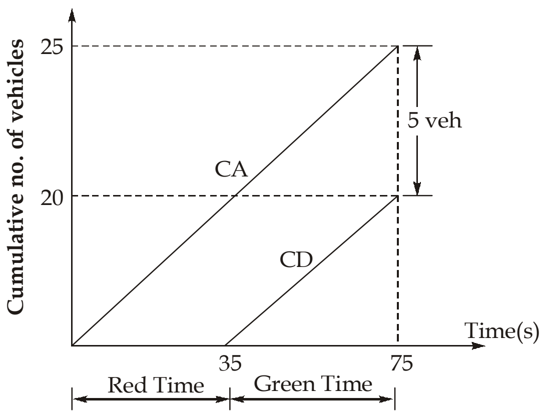
$$d = 0.278V_bT + (s_1 + s_2)$$

$\Rightarrow$ $d = 0.278 \times 50 \times 12 + 36$

$\Rightarrow$ $d = 202.8$ m

16. (b)

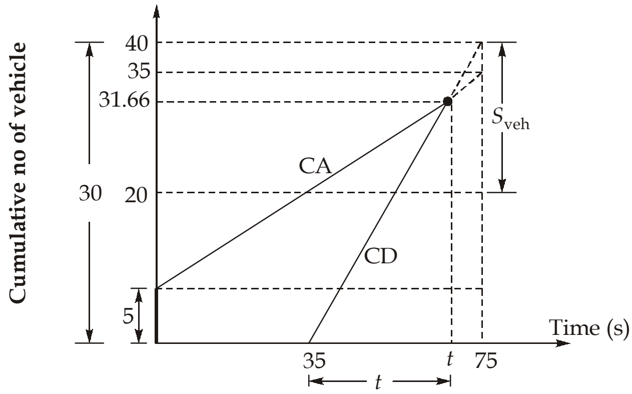
1st cycle:



$$\text{Cumulative arrival} = 20 \times \frac{75}{60} = 25 \text{ veh}$$

$$\text{Cumulative departure} = 30 \times \frac{40}{60} = 20 \text{ veh}$$

Next cycle:



$$\text{Cumulative arrival} = 20 \times 1.2 \times \frac{75}{60} + 5 = 35 \text{ veh}$$

$$\text{Cumulative departure} = 30 \times 2 \times \frac{40}{60} = 40 \text{ veh}$$

∴ Cumulative departure > Cumulative arrival is not possible. So let's say after (35 + t)s,

$CA = CD$

$$\Rightarrow \quad 5 + \frac{20 \times 1.2 \times (35 + t)}{60} = (30 \times 2) \times \frac{t}{60}$$

$$\Rightarrow \quad t = 31.67\text{s}$$

$$\therefore \quad \text{In } 31.67\text{s}, CD = 30 \times 2 \times \frac{31.67}{60} = 31.67 \text{ veh}$$

∴ Total number of vehicle having no delay = 35 – 31.67 = 3.33 ≃ 3 veh

17. (b)

Theoretical specific gravity,

$$G_t = \frac{100}{\frac{W_{CA}}{G_{CA}} + \frac{W_{FA}}{G_{FA}} + \frac{W_{\text{Fine}}}{G_{\text{Fine}}} + \frac{W_{\text{Bit}}}{G_{\text{Bit}}}}$$

$$= \frac{100}{\frac{60}{2.52} + \frac{25}{2.63} + \frac{10}{2.68} + \frac{5}{1.06}} = 2.3944$$

$$\text{Volume of paraffin wax coated sample} = \frac{(1290 - 703)g}{1 \text{ g/cc}} = 587 \text{cc}$$

$$\text{Bulk volume of sample} = 587 - \frac{1290 - 1240}{0.9} = 531.44 \text{ cc}$$

$$\text{Bulk specific gravity, } G_m = \frac{(1240/531.44) \text{ g/cc}}{1 \text{ g/cc}} = 2.3333$$

$$\text{Air voids, } V_a = \frac{G_t - G_m}{G_t} \times 100 = \frac{2.3944 - 2.3333}{2.3944} \times 100 = 2.55\%$$

Percentage volume of bitumen, $V_b = \frac{W_b}{G_b} \times \left(\frac{G_m}{W_T}\right) \times 100$

$$= \frac{5}{1.06} \times \left(\frac{2.3333}{100}\right) \times 100 = 11.01\%$$

Voids in mineral aggregate

$$VMA = V_a + V_b = 2.55\% + 11.01\% = 13.56\%$$

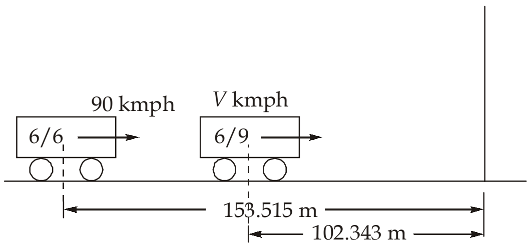
18. (c)

Safe stopping distance for 6/6 vision driver

$$SSD = vt + \frac{v^2}{2gf}$$

$$= \frac{90}{3.6}(2.5) + \frac{(90/3.6)^2}{2 \times 9.81 \times 0.35}$$

$$= 62.5 + 91.015 = 153.515 \text{ m}$$



For 6/9 vision driver, intersection will be visible, from 153.515 × 6/9 = 102.343 m

⇒ 6/9 vision driver will start reacting 102.343 m before intersection.

$$\Rightarrow \quad 102.343 = v(2.5) + \frac{v^2}{2 \times 9.81 \times 0.35}$$

$$\Rightarrow \quad 702.7894 = 17.1675v + v^2$$

$$\Rightarrow \quad v = 19.28 \text{ m/s}$$

$$\Rightarrow \quad V = 69.408 \text{ kmph} \simeq 70 \text{ kmph}$$

19. (d)

$$\because \quad e = \frac{V^2}{225R}$$

$$\therefore \quad e = \frac{100^2}{225 \times 500} = 0.088 > 0.07$$

So, $e = 0.07$

$$\Delta h = eB = 0.07 \times 7.5 = 0.525 \text{ m}$$

20. (b)

Case-1: As per rate of change of centrifugal force

$$L_{TC} = \frac{V^3}{CR}$$

where, $C = \frac{80}{75+V} = \frac{80}{75+70} = 0.5517 \text{ m/s}^2$ which lies between 0.5 and 0.8

(O.K)

$$\therefore \quad L_{TC} = \frac{(70/3.6)^3}{0.5517(250)} = 53.30\,\text{m}$$

Case-2: As per introduction of superelevation.

$$L_{TC} = eN(W + W_e)$$

($\because$ Heavy rainfall area, superelevation will be attained by rotating the outer edge)

$$e = \frac{V^2}{225R} = \frac{(70)^2}{225 \times 250} = 0.087 > 0.07$$

Now,

$$e + f = \frac{V^2}{127R} \text{(Take } e = e_{max} = 0.07 \text{ for plain terrain)}$$

$$\Rightarrow \quad 0.07 + f = \frac{70^2}{127(250)}$$

$$\Rightarrow \quad f = 0.0843 < 0.15 \qquad \therefore e = 0.07$$

N = rate of change in superelevation i.e. 1 in 150.

$$\therefore \quad L_{TC} = 0.07 \times 150 \times 7.615 = 79.96 \text{ m}$$

Case-3: As per emperical formula of IRC.

$$L_{TC} = 2.7\frac{V^2}{R}$$

$$= 2.7 \times \frac{70^2}{250} = 52.92\,\text{m}$$

$$\therefore \quad L_{TC} = \text{max.}[53.30 \text{ m}, 79.96 \text{ m}, 52.92 \text{ m}]$$

Hence, $L_{TC} = 79.96 \text{ m} \simeq 80 \text{ m}$

21. (d)

For section 1-2

$$\text{Weaving ratio} = \frac{b+c}{a+b+c+d}$$

where,

$$a = V_{12} = 50$$
$$b = V_{13} + V_{14} = 800 + 400 = 1200$$
$$c = V_{32} + V_{42} = 600 + 500 = 1100$$
$$d = V_{43} = 700$$

$$\therefore \quad \text{Weaving ratio} = \frac{1200+1100}{50+1200+1100+700} = 0.75$$

22. (b)

No. of vehicles running throughout the year

$$= 36.5 \times 10^6$$

$$\text{AADT} = \frac{\text{No. of vehicles running throghout the year}}{365} \text{veh/day}$$

$$AADT = \frac{36.5\times10^6}{365} = 10^5 \text{ veh/day}$$

Now, monthly expansion factor (MEF) $= \dfrac{AADT}{ADT}$

$$\Rightarrow \quad ADT = \frac{10^5}{2} = 5\times10^4 \text{ veh/day}$$

But $$ADT = \frac{\text{No. of vehicles running in a week}}{7}$$

$\Rightarrow$No. of vehicles running in a week $= ADT \times 7$

$= 5 \times 10^4 \times 7$

$= 35 \times 10^4$

23. (a)

$$V = \left[75 - \left(\frac{2}{3}\right) K\right]$$

Capacity, $q = V \times K$

$$= 75K - \frac{2}{3}K^2$$

For q to be maximum, $\dfrac{dq}{dK} = 0$

$$\Rightarrow \quad \frac{dq}{dK} = 75 - \frac{4}{3}K = 0$$

$$\Rightarrow \quad K = 56.25$$

$\therefore$ Maximum capacity, $q = 75K - \dfrac{2}{3}K^2$

$$= 75\times56.25 - \frac{2}{3}\times(56.25)^2$$

$$= 2109.375 \simeq 2109 \text{ veh/hr}$$

24. (c)

$$P_{(n,\ t)} = \frac{e^{-\lambda t}(\lambda t)^n}{n!}$$

Here, λ = No. of veh/h = 260 vehicles/hr $= \dfrac{260}{3600}$ veh/s

$$P\ (2,\ 30) = \frac{e^{-\frac{260\times30}{3600}} \times \left(\frac{260}{3600}\times30\right)^2}{2!}$$

$$= 0.269 \simeq 0.27$$

25. (c)

$$\frac{\log(ESWL)-\log(P)}{\log(2P)-\log(ESWL)} = \frac{\log Z-\log\frac{d}{2}}{\log 2S-\log Z} \quad \text{...(i)}$$

Here, ESWL = 62 kN

P = 35 kN

Z = 30 cm

S = 20 cm

d = ?

Substitute all the values in eq. (i)

$$\frac{\log 62-\log 35}{\log 70-\log 62} = \frac{\log 30-\log\frac{d}{2}}{\log 40-\log 30}$$

$\Rightarrow$ d = 15.47 cm

26. (c)

Theoretical specific gravity, $G_t = \dfrac{825+1200+325+150+100}{\dfrac{825}{2.63}+\dfrac{1200}{2.51}+\dfrac{325}{2.46}+\dfrac{150}{2.43}+\dfrac{100}{1.05}}$

G_t = 2.4055 g/cc

Bulk specific gravity, $G_m = \dfrac{M}{V}$ $\quad (\because \rho_w = 1 \text{ g/cc})$

$\Rightarrow$ $G_m = \dfrac{1100}{475} = 2.316$ g/cc

Percentage of air voids, $V_v = \dfrac{G_t-G_m}{G_t}\times 100 = \dfrac{2.4055-2.316}{2.4055}\times 100 = 3.72\%$

Total weight of all constituents = 825 + 1200 + 325 + 150 + 100 = 2600 g

Percentage of volume of bitumen,

$$V_b = G_m \times \frac{W_b\%}{G_b} = 2.316\times\frac{\frac{100}{2600}\times 100}{1.05} = 8.48\%$$

$\therefore$ VMA = $V_v + V_b$ = 3.72 + 8.48 = 12.2%

Voids filled with bitumen, VFB = $\dfrac{V_b\%}{VMA\%}\times 100 = \dfrac{8.48}{12.2}\times 100 = 69.51\% \simeq 0.695$

27. (c)

S_a = 1250 PCU/hr

S_b = 1000 PCU/hr

$$x_b = \frac{q_b}{s_b} = \frac{250}{1000} = 0.25$$

$$C_o = \frac{1.5L+5}{1-y}$$

$$L = 2n + R = 2 \times 2 + 12 = 6s$$

$$C_o = 67.5 - \frac{1.5\times 16+15}{1-y}$$

$$1 - y = \frac{29}{67.5}$$

$$y = 0.57$$

$$y_a + y_b = 0.57$$

$$y_a = 0.32$$

$$y_a = \frac{q_a}{s_a} = 0.32$$

$$q_a = 0.32 \times 1250$$

$$q_a = 400 \text{ PCU/hr}$$

28. (b)

As, vehicle travelling towards upgrade requires 10 m less than travelling towards downgrade with same grade, so

$$\frac{V^2}{254(f+n)} = \frac{V^2}{254(f-n)} - 10$$

$$\Rightarrow \quad \frac{65^2}{254(0.4+n)} = \frac{65^2}{254(0.4-n)} - 10$$

$$\Rightarrow \quad 16.63\left(\frac{1}{0.4-n} - \frac{1}{0.4+n}\right) = 10$$

$$\Rightarrow \quad 3.33n = 0.4^2 - n^2$$

$$\Rightarrow \quad n^2 + 3.33n - 0.4^2 = 0$$

$$\Rightarrow \quad n = 0.0474$$

So, gradient of pavement is 4.74%.

29. (a)

Given,

$$\text{Average arrival rate, } \lambda = 260 \text{ veh/hr}$$

$$= \frac{260}{3600} \text{ veh/sec}$$

We know,

$$P(x = n) = \frac{e^{-\lambda t}\cdot(\lambda t)^n}{n!}$$

$$P(x = 0) = \frac{e^{-\left(\frac{260}{3600}\times 3\right)}\cdot\left(\frac{260}{3600}\times 3\right)^0}{0!} = 0.805$$

30. (c)

Road	Length (km)	Total utility served by the road	Utility per unit length	Priority
P	500	$100 \times 1 + 70 \times 2 + 50 \times 4 + 20 \times 8 + 50 \times 2 + 20 \times 10 = 900$	$\frac{900}{500} = 1.8$	II
Q	600	$200 \times 1 + 120 \times 2 + 30 \times 4 + 10 \times 8 + 60 \times 2 + 25 \times 10 = 1010$	$\frac{1010}{600} = 1.683$	IV
R	800	$100 \times 1 + 90 \times 2 + 80 \times 4 + 80 \times 8 + 30 \times 2 + 15 \times 10 = 1450$	$\frac{1450}{800} = 1.625$	I
S	900	$150 \times 1 + 130 \times 2 + 100 \times 4 + 10 \times 8 + 50 \times 2 + 12 \times 10 = 1110$	$\frac{1110}{900} = 1.23$	IV

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