9. A passenger car weighing 10 kN is required to accelerate at a rate of 2m/s2 in the first gear from a speed of 10 kmph to 20 kmph. The gradient is +2 percent and the road has a WBM surface in good condition. Frontal projection of the area of the car is 2.15 m2. Car tyres have radius of 0.33 m. The rear axle gear ratio is 3.82:1 and the first gear ratio if 2.78:1. Calculate the engine horse power needed and the speed of the engine. Make suitable assumptions. Coefficient of air resistance =0.39, coefficient of rolling resistance =0.025. Tyre deformation factor = 0.945, transmission efficiency = 0.9.

Weight = 10000/9.81=1019.4 kg

Average speed = 15 kmph = 15×5/18= 4.17 m/s

Tractive force   Pp = Pf + Pa ± Pi ± Pj

Pf = mgf = 1019.4×9.81×.025 = 250 N

Pa = Ca×A v^2 = 0.39×2.15×$(4.17)^2$ =14.58 N

Pi = mgi = 1019.4×9.81×2/100 =200 N

Pj = m a = 1019.4×2 = 2038.8 N

Pp = 250+14.58+200+2038.8= 2503.4

Power output, watt = Pp×v = 2503.4×4.17=10439.1 W

Power output, hp = 10439.1 /735=14.2 hp

Engine power, hp = Power output/ transmission efficiency

=14.2 /0.9 = 15.78 hp

$$v = \frac{2\,\pi r_w n}{60\,G_t G_a}$$

Where,

Gt: transmission gear ratio

Ga: rear axle gear ratio

n : engine speed in RPM

r_w: $\lambda\, r_0$

λ : tyre deformation factor

$$4.17 = \frac{2\,\pi \times 0.33 \times 0.945 \times n}{60 \times 3.82 \times 2.78}$$

n = 1356 rpm

11. A car weighing 1300 kg and travelling at a speed of 65 kmph on a level road of rolling resistance coefficient 0.025, is allowed to coast by suddenly switching off the engine and putting the gear in neutral. If coefficient of air resistance is 0.37 and frontal area is 1.65 m2, find the deceleration caused. In how much distance will the car come to a halt?

Average speed = 65 kmph = 65×5/18= 18.06 m/s

Tractive force Pp = Pf + Pa ± Pi ± Pj

Pf = mgf = 1300×9.81×.025 = 318.83N

Pa = Ca×A v^2 = 0.37×1.65×$(18.06)^2$ =199.1N

Pi = mgi = 0

Pj = m a = 1300a

Pp = 318.83+199.1-1300a=0

Or a =0.398m/s^2

$$v^2 = u^2 - 2aS$$

$$0 = 18.06^2 - 2 \times 0.398 \times S$$

$$S = 409.8\ m$$

13. A passenger car, weighing 2500 kg, is required to accelerate at a rate of 3.5 m/sec^2 in the first gear from a speed of 10 kmph to 20 kmph. The gradient is +1,2% and the road has a black topped surface, with a frictional coefficient of 0.02. the frontal projectional area of the car is 2.5m2 with Ca = 0.37. The car has tyres of radius 0.35 m with a λ = 0.935. The rear axle gear ratio is 3.85:1 and first gear ratio of 2.98:1. Assume transmission efficiency of 0.9 and hence calculate engine horse power needed and speed of the engine in rpm.

Weight = 2500 kg

Average speed = 15 kmph = $15\times5/18= 4.17$ m/s

Tractive force $\quad Pp = Pf + Pa \pm Pi \pm Pj$

$Pf = mgf = 2500\times9.81\times.02 = 490.5$ N

$Pa = Ca\times A\ v^2 = 0.37\times2.5\times(4.17)^2 = 16.08$N

$Pi = mgi = 2500\times9.81\times1.2/100 = 294.3$N

$Pj = m\ a = 2500\times3.5 = 8750$ N

$Pp = 490.5+16.08+294.3+8750= 9550.88$N

Power output, watt = $Pp\times v = 9550.88\times4.17=39827.2$ W

Power output, hp = 39827.2 /735=54.2 hp

Engine power, hp = Power output/ transmission efficiency

=54.2 /0.9 = 60.21 hp

$$v = \frac{2\,\pi r_w n}{60\,G_t G_a}$$

Where,

Gt: transmission gear ratio

Ga: rear axle gear ratio

n : engine speed in RPM

r_w: $\lambda\, r_0$

λ : tyre deformation factor

$$4.17 = \frac{2\,\pi \times 0.35 \times 0.935 \times n}{60\ \times 3.85 \times 2.98}$$

$$n = 1397 \text{ rpm}$$

15. In a road test for measuring the skid resistance using skid resistance equipment, the timer indicates 4.25 secs after the brake application. Braking distance was measured to be 32.3 m before the vehicle was brought to halt. What is the average skid resistance of the surface?

$v^2 = u^2 - 2aS$

$0 = u^2 - 2aS$

$u^2 = 64.6a$ (1)

$v = u + at$ or u=4.25a (2)

Substituting (2) in (1)

$18.06a^2 = 64.6$ a

Or a=3.58 = 9.81×f

Or f = 0.365

composition of traffic and traffic volume.

20. Estimate the theoretical capacity of a lane, with one way traffic flow at a stream speed of 50 kmph. Assume average speed gap between the vehicles to follow a relationship $S_g = 0.278$ Vt with a reaction time of 0.75 seconds. Assume the average length of the vehicle travelling at 6 m and hence evaluate capacity for a two lane system.

Theoretical capacity of a single lane, $C = \frac{1000V}{S}$

Where, C is the capacity of a single lane, veh/hr

V is the speed in kmph

S is the average centre to centre spacing of vehicles, m

Given average speed gap, $S_g = 0.278$ Vt

$S = S_g + L = 0.278 \times 50 \times 0.75 + 6 = 16.425$ m

$$C = \frac{1000V}{S} = \frac{1000 \times 50}{16.425} = 3044 veh/hr$$

Capacity of a two lane system = 6088 *veh/hr*

27. **The speed and concentration of a vehicle in a traffic stream were observed and the following data are obtained. Find the linear regression equation for determining the speed and concentration.**

K (VPH)	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
V (KMPH)	**72**	**68**	**61**	**52**	**47**	**39**	**32**	**27**	**20**	**13**

K (vehicle/km), (x)	**V (kmph), (y)**	$x_i y_i$	x_i^2
5	72	360	25
10	68	680	100
15	61	915	225
20	52	1040	400
25	47	1175	625
30	39	1170	900
35	32	1120	1225
40	27	1080	1600
45	20	900	2025
50	13	650	2500
Average= 27.5	Average= 43.1	Sum = 9090	Sum =9625

$$\hat{b} = \frac{\sum x_i y_i - n\,\bar{x}\bar{y}}{\sum x_i^2 - n\,\bar{x}^2}$$

$$= \frac{9090-10*27.5*43.1}{9625 - 10*27.5^2}$$

$= -1.34$

$$\hat{a} = \bar{y} - \hat{b}\,\bar{x}$$

$= 43.1-(-1.34)*27.5$

$=79.95$

So the equation is

$V = 79.95-1.34k$

5. The data shown below were noted in a travel time study on 2 km stretch on a highway using moving observer method. Determine the travel time and flow in each direction

Direction	Travel time minutes	Number of vehicles		
		Traveling in opposite direction	Overtaking test vehicle	Overtaken by test vehicle
North Bound (NB)				
1	3.20	75	3	1
2	2.80	80	2	2
3	3.25	85	0	1
4	3.01	70	2	1
Average	3.07	77.5	1.75	1.25
South Bound (SB)				
1	3.30	78	4	0
2	3.25	74	2	2
3	3.40	79	0	2
4	3.35	82	3	3
Average	3.33	78.25	2.25	1.75

Flow in north can be calculated

$$q_n = \frac{x_s + y_n}{t_s + t_n}$$

$$q_n = \frac{78.25 + (1.75 - 1.25)}{3.33 + 3.07}$$

= 12.30 PCUs/ min

17. **Develop a linear relationship from the following speed-density data and determine optimum speed, jam density and free speed**

Density, VPH, (x)	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Speed, KPH, (y)	**60**	**50**	**45**	**40**	**35**	**30**	**20**	**15**	**10**	**5**

Density, VPH, (x)	10	20	30	40	50	60	70	80	90	100	**550**
Speed, KPH, (y)	60	50	45	40	35	30	20	15	10	5	**310**
x_iy_i	600	1000	1350	1600	1750	1800	1400	1200	900	500	**12100**
x_i^2	100	400	900	1600	2500	3600	4900	6400	8100	10000	**38500**

$$\hat{b} = \frac{\sum x_i y_i - n\bar{x}\bar{y}}{\sum x_i^2 - n\bar{x}^2} = \frac{12100 - 10 \times 55 \times 31}{38500 - 10 \times 55 \times 55} = \frac{-4950}{8250} = -0.6$$

$$\hat{a} = \hat{y} - \hat{b}\bar{x} = 31 + 0.6 \times 55 = 64$$

So, the equation is v=64-0.6k

Mean journey time in north

$$t_n = \overline{t_n} - \frac{y_n}{q_n}$$

$$t_n = \overline{3}.07 - \frac{1.75-1.25}{12.30}$$

$$= 3.02 \text{ min}$$

Flow in south can be calculated

$$q_s = \frac{x_n + y_s}{t_s + t_n}$$

$$q_s = \frac{77.5 + (2.25 - 1.75)}{3.33 + 3.07}$$

$$= 12.18 \text{ PCUs/min}$$

Mean journey time in south

$$t_s = \overline{t_s} - \frac{y_s}{q_s}$$

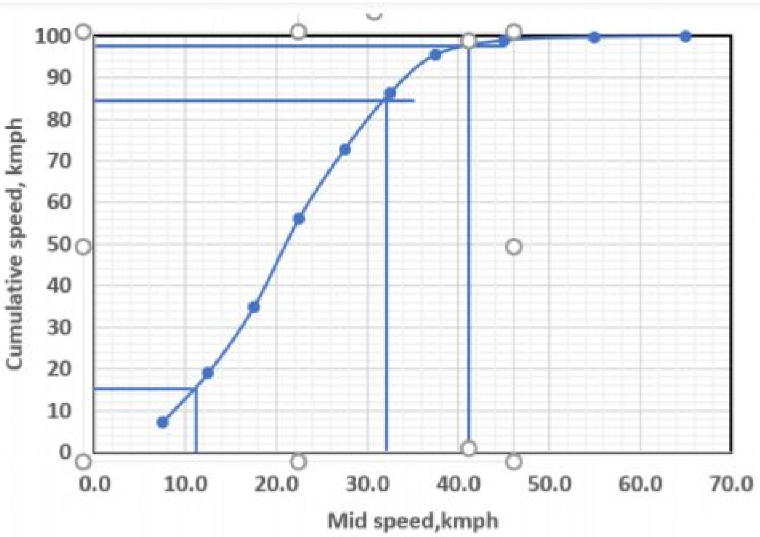
$$t_s \overline{=} 3.33 - \frac{2.25-1.75}{12.18}$$

$$= 3.28 \text{ min}$$

4. **Following data were obtained from the spot speed studies. Suggest (i)Speed limit for regulation (ii) Lower speed causing congestion (iii) Speed to check geometric deign elements.**

Speed Group (kmph)	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**	**40-50**	**50-60**	**60-70**
No. of vehicles	**230**	**375**	**500**	**680**	**525**	**430**	**290**	**110**	**25**	**8**

Mid speed kmph	**No of vehicles**	**Cumulative no of vehicles**	**Cumulative % vehicles**
7.5	**230**	**230**	**7.25**
12.5	**375**	**605**	**19.07**
17.5	**500**	**1105**	**34.83**
22.5	**680**	**1785**	**56.26**
27.5	**525**	**2310**	**72.80**
32.5	**430**	**2740**	**86.35**
37.5	**290**	**3030**	**95.49**
45.0	**110**	**3140**	**98.96**
55.0	**25**	**3165**	**99.75**
65.0	**8**	**3173**	**100.00**
	3173		



i)Speed limit for regulation =V85=32kmph

(ii) Lower speed causing congestion = V15=11 kmph

(iii) Speed to check geometric deign elements = V98 = 41kmph