7. Explain how overtaking sight distance (OSD) is calculated using IRC and AASHTO methods. (3)

OSD = $d_1 + d_2 + d_3$ (IRC)

$= V_b t + (2S + V_b) T + VT$

$T = ?$

IS.

AASHTO

$= d_1 + d_2 + d_3 + d_4$.

1

Explain??

Some useful formulas

$P_i = \dfrac{e^{U_i}}{\sum_{i=1}^{n} e^{U_i}}$; $\min S(x) = \sum_a x_a t_a(x_a)$; $f_{rl} = 0.01(1 + \dfrac{V}{44.73})$; , $P_{Ai} = (\rho/2) C_d A_f V^3$;

$\bar{v}_s = \dfrac{1}{\frac{1}{n}\sum_{i=1}^{n}\left[\frac{1}{v_i}\right]}$; $v_t = \Sigma v_i/n$; $q = k\,\bar{v}_s$; $P(n) = (\lambda t)^n \exp(-\lambda t)/n!$

CEL 241: TRANSPORTATION ENGINEERING-I

Minor-II — Maximum Marks: 20 — $\frac{17}{20}$ — 07th Oct 2013

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Instructions: i) Answer **ALL** the questions in the space provided, ii) Assume any data required suitably, and iii) Some useful formulas are given at the end.

1. The utility function of a logit model of choice between car, carpool and bus are given below, where A/W indicates number of cars per household;

$V_C = -T_C - 5C_C/Y + 0.10A/W$; $V_{CP} = -T_{CP} - 5C_{CP}/Y + 0.05A/W$; $V_B = -T_B - 5C_B/Y$

Show that if the coefficients b_1 and b_2 have appropriate values (find those values), you obtain the same choice probabilities from logit model whose utility function is: (3)

$V_C = -T_C - 5C_C/Y$; $V_{CP} = -T_{CP} - 5C_{CP}/Y + b_1A/W$; $V_B = -T_B - 5C_B/Y + b_2A/W$

Utility	Car	Carpool	Bus
V_C	$-T_C - \frac{5C_C}{Y} + \frac{.10A}{W}$	$-T_{CP} - \frac{5C}{Y} + \frac{.05A}{W}$	$-T_B - \frac{5C_B}{Y}$
2nd	$-T_C - \frac{5C_C}{Y}$	$-T_{CP} - \frac{5C_{CP}}{Y} + b_1\frac{A}{W}$	$-T_B - \frac{5C_B}{Y} + b_2\frac{A}{W}$

Pcar = $\frac{e^{-T_C - \frac{5C}{Y}} \cdot e^{\frac{.10A}{W}}}{\sum_{i=1}^{n} e^{U_i}}$ → 1st case ; $= \frac{e^{-T_C - \frac{5C}{Y}}}{\sum e^{U_C}}$ → 2nd case

$e^{.1\frac{A}{W}}\left(e^{-T_C - \frac{5C_C}{Y}} + e^{-T_{CP} - \frac{5C_{CP}}{Y} + b_1\frac{A}{W}} + e^{-T_B - \frac{5C_B}{Y} + b_2\frac{A}{W}}\right)$

$= e^{-T_C - \frac{5C_C}{Y} + \frac{.1A}{W}} + e^{-T_{CP} - \frac{5C_{CP}}{Y} + \frac{.05A}{W}} + e^{-T_B - \frac{5C_B}{Y}}$

$e^{-T_C - \frac{5C_C}{Y} + \frac{.1A}{W}} + e^{-T_{CP} - \frac{5C_{CP}}{Y} + (b_1 + .1)\frac{A}{W}} + e^{-T_B - \frac{5C_B}{Y} + (b_2 + .1)\frac{A}{W}}$

$= e^{-T_C - \frac{5C}{Y} + \frac{.1A}{W}} + e^{-T_{CP} - \frac{5C_{CP}}{Y} + \frac{.05A}{W}} + e^{-T_B - \frac{5C_B}{Y}}$

comparing coefficient

$(b_1 + .1) = .05$ $\qquad$ $b_2 + .1 = 0$

$b_1 = .05 - .1$ $\qquad$ $b_2 = -.1$

$= -.05$

2. Define user equilibrium through Wardrop's first principle? How would you arrive at user optimal flows by mathematical programming method? (2)

Wardrop's 1st principle says that in congested road the ~~so~~ used road have equal or minimum ~~travel~~ ~~time~~ cost and ~~used~~ unused road have greater cost

(2) min $S(x) = \sum_{i=1}^{n} x_i t_i$ → user optimal flows

$\left(\frac{ds}{dx}\right)$

3. Two routes connect an origin-destination pair with performance functions, $t_1 = 5 + 3x_1$ and $t_2 = 7 + x_2$, with the x's expressed in thousands of vehicles per hour and t's expressed in minutes. The origin-destination demand is 7000 veh in peak hour. What is the value of the derivative of the user equilibrium math program evaluated at the system-optimal solution with respect to x_1 (x_1 equal to system-optimal solution) $\frac{ds}{dx}$ (4)

route 1 route 2

min $t_1 = 5 + 3x_1$ veh/hr $t_2 = 7 + x_2$ veh/hr

$q = 7$ veh/hr

$x_1 + x_2 = 7$

$\left(\frac{ds}{dx}\right)$ of user eqbm at x_1 obtained from system optimal

) = System optimal $\Rightarrow x_1 t_1 + x_2 t_2$.

$x_1(5+3x_1) + x_2(7+x_2)$.

$x_2 = 7 - x_1$

4

$\Rightarrow 5x_1 + 3x_1^2 + (7-x_1)(7+7-x_1)$.

$5x_1 + 3x_1^2 + (7-x_1)(14-x_1)$.

$5x_1 + 3x_1^2 + 98 - 7x_1 - 14x_1 + x_1^2$

$\Rightarrow \cancel{9x_1^2 - 21x_1 + 98}$

$\cancel{\frac{ds(x)}{dx_1} = 0, \; 18x_1 - 21 = 0}$

$x_1 = \frac{21}{18} = \frac{7}{6} = 1.167$ veh/hr.

now

$S(x) \; 4x_1^2 - 16x_1 + 98$

$\frac{d(S(x))}{dx_1} = 0 = 8x_1 - 16 \Rightarrow x_1 = \frac{16}{8} = 2$ veh/h

4. Assume that you are standing adjacent to a six-lane divided highway (three lanes in each direction). Lane 1 has vehicles traveling at 50 km/h, and lane 2 vehicles at 75 km/h, and lane 3 vehicles at 100 km/h. The spacing between vehicles on each of the lane is 150 m, and your observation period is 30 minutes. What is the time mean speed of the traffic stream? (2)

Lane 1 Lane 2 Lane 3

50km/hr 75Km/h 100 Km/hr

$l = 6 \times 150\text{m} = 900\text{m}$.

$n_1 = \frac{50 \text{ Km/hr}}{} = 27.78$ $n_2 = 41.67$ $n_3 = 55$

A vehicle manufacturer is considering an engine for a new sedan to be launched ($C_D = 0.30$, $A_f = 20$ ...). The car will be tested at a maximum speed of 160 km/h on a paved surface at sea level ($\rho = 1.2256$ ...$/m^3$). The car currently weighs 9.3 kN, but the designer selected an underpowered engine because ...rodynamic and rolling resistance were ignored. If 9N of additional vehicle weight is added for each ...owatt needed to overcome the neglected resistance, what will be the final weight of car it is to ...hieve the 160 km/h top speed? (3)

$\frac{km}{hr} \times \frac{5}{18} = 44.44 m/s$ $\quad P_{max} = (R_a + R_{rl}) V_{max}$

$R_a = \frac{1}{2} C_d A_f V_{max}^2 = \frac{1.2256 \times .30 \times \cancel{2} \times (44.44)^2}{\cancel{2}}$

$= 726.136N = .726KN$

$f_{rl} = .01(1 + \frac{V}{44.73}) = .01(1 + \frac{44.44}{44.73}) = .0$

$\approx .$

$R_{rl} = f_{rl} \times w = .02 \times 9.3$

$= .186 KN$

$P_{max} = (.726 + .186)\ 44.44 = 40.529$ K

$1kw \rightarrow \cancel{9k}\ 9N$ or 9×10^{-3} KN is added

so for

$40.529\ kw \rightarrow 9 \times 10^{-3} \times 40.529 = .36$

so final weight

$9.3 + .365$

$= 9.665KN$

5. An observer counts 360 veh/h at a specific highway location. Assuming that the arrival of vehicles at this location is Poisson distributed, estimate the probability of having 4 or more vehicles arriving over a 20-second interval. (3)

$q = 360$ veh/hr $\rightarrow \lambda$

$P(0) = \frac{(360(\frac{20}{3600}))^0 (e^{-360 \times \frac{20}{3600}})}{0!}$

20

40