Problem 1.

S - saturation flow $S = 1600 \text{ veh/hr}$; $\mu = 0.417 \text{ veh/sec}$ - departure rate

R - arrival rate $R = 400 \text{ veh/hr} = 0.22 \text{ veh/sec}$

C - cycle length of a signal $c = 60 \text{ sec} = r + g$

D/D/1 queuing holds

$r$ - effective red light

$g$ - effective green light

$Q$, number of vehs

$t_0$, the time from start of the effective green to queue dissipation

$r + t_0 \leq 50 \text{ sec.}$

$t_0 = \frac{Pr}{1-P}$; $P = \frac{R}{\mu} = \frac{0.22}{0.417} = 0.53$

$t_0 = \frac{0.53r}{1 - 0.63} = 1.14 \text{ r sec.}$

$r + 1.14r \leq 50$

$2.14r \leq 50$

$r \leq 23.4$

$r = 23.4 \text{ sec} -$ maximum length of effective red signal.
Problem 2.

$r$ - effective red time; \( r = 30 \) sec

D/D/1 queuing holds

\[ S = 1000 \text{veh/hr} \]

Total delay is \( 3.33 \) veh/hr \( S = D_t \)

\[ m = 0.274 \text{veh/sec} \]

\[ D_t = \frac{(r + t_o)}{2}, \quad R_t = 3.33 \]

\[ R = \frac{2D_t}{(r + t_o)r} \quad (1) \]

\[ P = \frac{\lambda}{\mu} \quad t_o = \frac{PR}{1 - P} \quad (l - \frac{r}{\mu})t_o = \frac{R}{\mu} r \]

\[ \frac{\mu - 3}{\mu} t_o = \frac{3}{\mu} r \quad (\mu - R)t_o = Rr \quad \lambda = \frac{t_o \mu}{r + t_o} \quad (2) \]

Since (1) equals (2), then:

\[ \frac{8 \times 3.33}{(30 + t_o)r} = \frac{t_o \times 0.274}{30 + t_o} \quad \Rightarrow \quad t_o \approx 20 \text{sec.} \]

\[ \lambda = \frac{20 \times 0.274}{30 + 20} = 0.11 \text{ veh/sec} = 399.6 \approx 400 \text{ veh/hr} \]

\[ \mu g = 1 \quad \Rightarrow \quad \mu g = \lambda (r + g) \quad \Rightarrow \quad g \approx 20 \text{ sec} \]

\[ C = r + g = 30 + 20 = 50 \text{ sec}. \]