(5) $\lambda = \frac{1}{15}$ cars/min

The computed values of all three steps is equivalent to the sum of values computed for each step.

(a) $\mu_1 = 1/3$

$\mu_2 = 1/6$

$\mu_3 = 1/9$

The queue is of M/M/c type where $c=2$.

$$\rho_1 = \frac{\lambda}{c\mu_1} = \frac{1/15}{2\times 1/3} = \frac{3}{2\times 15} = \frac{1}{10}$$

$\rho_1 < 1$

$$P_0 = \left(\sum_{m=0}^{c-1} \frac{(c\rho)^m}{m!} + \frac{(c\rho)^c}{c!} \left(\frac{1}{1-\rho} \right) \right)^{-1}, \quad \rho = \frac{\lambda}{c\mu} < 1$$

$$= \left(\frac{1}{0!} + \frac{(2\times 1/10)^1}{1!} + \frac{(2\times 1/10)^2}{2!} \left(\frac{1}{1-1/10} \right) \right)^{-1}$$

$$= \left(1 + \frac{1}{5} + \frac{1}{\cancel{2\times}5\times5} \times \frac{}{9}\right)$$

$$= \left(1 + \frac{1}{5} + \frac{1}{45}\right)^{-1}$$

$$= \left(\frac{225 + 45 + 5}{45 \times 5}\right)^{-1}$$

$$= \left(\frac{275}{225}\right)^{-1}$$

$$= 0.8182$$

$$P(m \geq c) = \frac{(\rho c)^c P_0}{c!\,(1-\rho)}$$

$$= \frac{\left(\frac{1}{10} \times 2\right)^2 \times 0.8182}{}$$

$$\overline{\qquad\qquad}$$
$$2!\ (1-1/10)$$

$$= \frac{1/25 \times 0.8182}{2 \times 9/10}$$

$$= \frac{0.8182 \times 10}{2 \times 25 \times 9}$$

$$= \frac{8.182}{50 \times 9} = \frac{8.182}{450}$$

$$= 0.0181822$$

$$L = c\rho + \rho \frac{P(m \geq c)}{1-\rho}$$

$$= 2 \times 1/10 + \frac{1/10}{9/10} \times 0.0181822$$

$$= \frac{1}{5} + \frac{1}{9} \times 0.0181822$$

$$= \frac{1}{5} + 0.002020$$

$$= 0.2020$$

The above value is $L_1 = 0.2020$

$$W_1 = \frac{L_1}{\lambda} = \frac{0.2020}{1/15}$$

$$= 3.0303$$

$$W_{Q,1} = W_1 - \frac{1}{\mu_1}$$

$$= 3.0303 - 3$$

$$= 0.0303$$

$$L_{Q,1} = \lambda W_{Q,1}$$

$$= \frac{1}{15} \times 0.0303$$

$$= 0.0020$$

Now we repeat the same steps for $\mu_2 = 1/6$

$1/5 \quad \frac{3}{\;} = \frac{1}{5} = 0.2$