(a)

(i)

$M/M/1$: $\mu=3$ $\lambda=2$ $L=\frac{\lambda}{\mu-\lambda}=\frac{2}{3-2}=2$

$M/M/1/3$: $\mu=3$ $\lambda=2$ $L=\frac{\rho[1-\rho^3-3\rho^3(1-\rho)]}{(1-\rho)(1-\rho^4)}$

$\rho=\frac{\lambda}{\mu}=\frac{2}{3} \Rightarrow L=\frac{60}{65}$

$M^3/M/1$: $\mu=3$ $\lambda=\frac{2}{3}$ $L=\frac{\rho(1+b)}{2(1-\rho)}$

$\rho=\frac{b\lambda}{\mu}=\frac{3\times\frac{2}{3}}{3}=\frac{2}{3} \Rightarrow L=\frac{\frac{2}{3}(1+3)}{2(1-\frac{2}{3})}=4$

$M/M/3$: $\mu=2$ $\lambda=2$ $L=\frac{\rho(3\rho)^3\pi_0}{6(1-\rho)^2}+\frac{\lambda}{\mu}$

$\rho=\frac{\lambda}{m\mu}=\frac{2}{3\times2}=\frac{1}{3}$ $\pi_0=\left[\frac{(3\rho)^3}{6(1-\rho)}+\sum_{k=0}^{2}\frac{(3\rho)^k}{k!}\right]^{-1}$

$=\left[\frac{1}{6\times\frac{2}{3}}+\sum_{k=0}^{2}\frac{1}{k!}\right]^{-1}=\frac{4}{11}$

$L=\frac{\frac{1}{3}\pi_0}{6(\frac{2}{3})^2}+1=\frac{23}{22}$

(ii)

$W = \frac{L}{\lambda}$ $\quad W_1 = \frac{L_1}{\lambda} = \frac{2}{2} = 1$

$$W_2 = \frac{L_2}{\lambda} = \frac{\frac{66}{65}}{2} = \frac{33}{65}$$

$$W_3 = \frac{L}{\lambda b} = \frac{4}{\frac{2}{3} \times 3} = 2$$

$$W_4 = \frac{L}{\lambda} = \frac{\frac{23}{22}}{2} = \frac{23}{44}$$

(iii)

$M/M/1$: $\frac{100}{40-20} = 5$

$M/M/c/3$ $\frac{300}{120-90} = 10$

$M^3/M/1$ $\frac{100}{30-18} = \frac{50}{6}$

$M/M/3$ $\frac{150}{100-60} = \frac{15}{4}$

(b)

Choose $M/M/3$

① short waiting time

② quick break-even time

③ highest monthly profit