Question 1

Let

$$\begin{aligned} T_{file} &= \text{transmission time of the file over one link} \\ &= \frac{L}{R} \\ &= \frac{15 \text{ Mbits}}{10 \text{ Mbit/sec}} = 1.5 \text{ sec}, \end{aligned}$$

$$\begin{aligned} T_{file+header} &= \text{transmission time of the file in one packet over one link} \\ &= \frac{L+H}{R} \\ &= \frac{(15 \text{ Mbits} + 40 \text{ bits})}{10 \text{ Mbit/sec}} \approx 1.5 \text{ sec, and} \end{aligned}$$

$$\begin{aligned} T_{pkt} &= \text{transmission time of one packet over one link} \\ &= \frac{(L/p)+H}{R} \\ &= \frac{(1.5 \text{ Mbits} + 40 \text{ bits})}{10 \text{ Mbit/sec}} \approx 0.15 \text{ sec.} \end{aligned}$$

Then

a) For circuit switching:

$$T_1 = T_{file} + d_{cs} = 1.5 + 5 = 6.5 \text{ sec}$$

b) For packet switching with $p = 1$ packet:

$$T_2 = 3T_{file+header} \approx 4.5\text{sec}$$

c) For packet switching with $p > 1$ packets:

$$T_3 = 3T_{pkt} + (p-1)T_{pkt} = (p+2)T_{pkt} \approx 12 \times 0.15 = 1.8 \text{ sec.}$$

d) Assuming $p > 1$, to ensure that $T_1 < T_3$, we need

$$T_{file} + d_{cs} < (p+2)T_{pkt}$$

For the given numerical values, we need d_{cs} to be the maximum possible value that is less than $(p+2)T_{pkt} - T_{file}$ (≈ 0.3 sec).

e) See the above calculations.
