1. (a) Along all paths, p and q hold true in alternate states

CTL: $AG((p \to AXq) \wedge (q \to AXp) \wedge AG(p \vee q) \wedge \neg AG(p \wedge q))$

LTL: $(p \to Xq) \wedge (q \to Xp) \wedge G(p \vee q) \wedge \neg G(p \wedge q)$

(b) Along all paths, eventually a state is reached such that all its next states satisfy p

CTL: $EFAXp$

LTL: if we want to FXp to represent it, it does not satisfy the requirement sometimes, it cannot satisfy <u>AX</u>.

FXp and $AFAXp$ Example can also explain this (lecture Week-11-2)

(c) There exists no path where p holds true until q holds true.

CTL: $\neg E(p \,U\, q)$

LTL: $\neg(p \,U\, q)$

(d) There exists a path where p holds in a state and it is followed by a q

CTL: $EFp \to AXAFq$

LTL: $Fp \to XFq$ cannot satisfy the requirement.

from (b), it cannot be verified using LTL model checking.

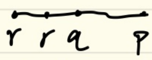
2. (a) $F(X(b))$: $\{s_0, s_1, s_2, s_3, s_4\}$

(b) $(F(G(b)) \,U\, a)$: $\{s_0, s_1, s_2, s_3\}$

(c) $G(F(a)) \to G(F(b))$: $\{s_0, s_1, s_2, s_3, s_4\}$

(d) $G(F(b)) \to G(F(a))$: $\{\}$

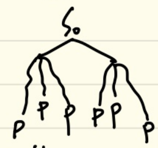
3. (a) False. $\pi \models (Fp \,U\, q)$ and $\pi^0 \not\models q$



let $Fp = r$ (r will reach p)

In this case, $r(Fp) \to r(Fp) \to q$, but p doesn't hold true before q.

(b) $AXAFp$ iff $\pi \models FXp$ is true



In right hand, this rough graph is representing $AXAFp$, we can see $\pi \models FXp$. Therefore $AXAFp$ (CTL) $\equiv$ FXp (LTL)

(c) $FGp \to GFp$ is true. FGp: in some future suffix, p holds true in all suffix. and GFp means for all suffix, they can reach p eventually. So we can say $FGp \to FGp$