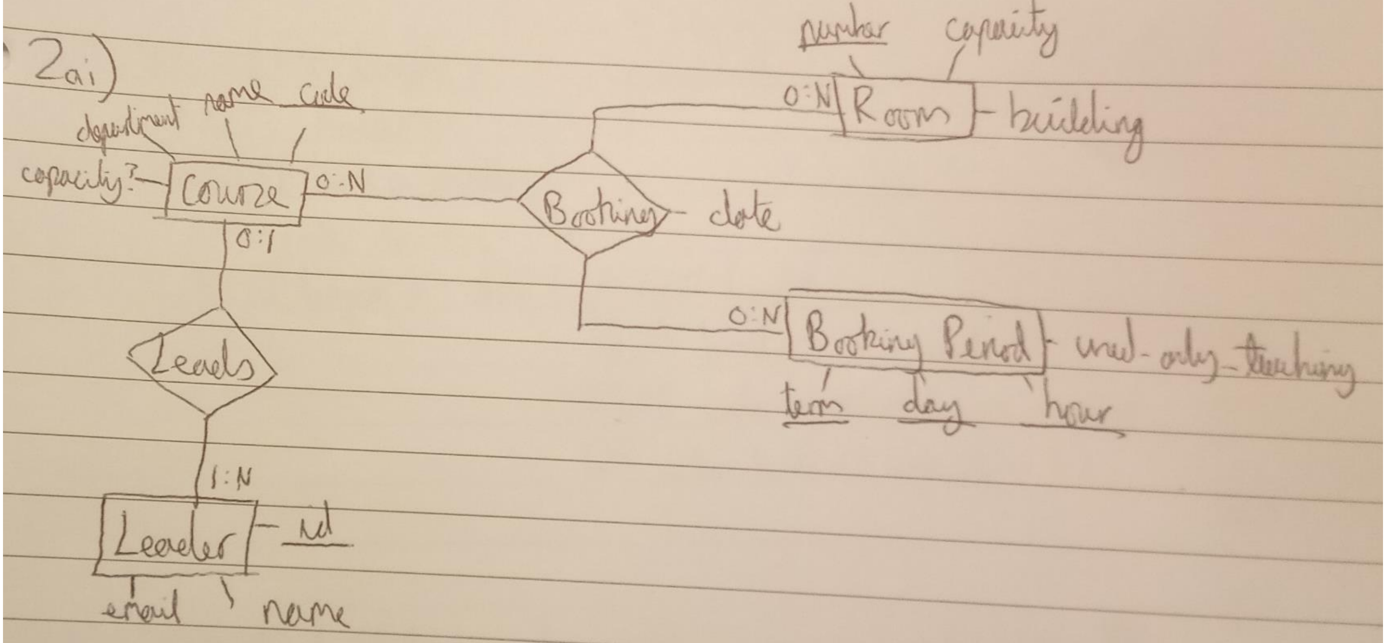
2a i)



ii) course (<u>code</u>, name, department, capacity ?, leader_id?)
leader (<u>id</u>, name, email)

course (leader_id) $\xrightarrow{fk}$ leader(id)

room (<u>number</u>, capacity, building)

booking_period (<u>term</u>, <u>date</u>, <u>hour</u>, uni-only-teaching)

booking (<u>room_number</u>, <u>period_term</u>, <u>period_day</u>, <u>period_hour</u>, <u>course_code</u>, date)

booking (room_number) $\xrightarrow{fk}$ room (number)
booking (period_term, period_day, period_hour) $\xrightarrow{fk}$ booking_period (term, day, hour)
booking (course_code) $\xrightarrow{fk}$ course (code)

2b.i) $S = \{ AE \to AEF,\ B \to DC,\ D \to B,\ DH \to C,\ C \to H,\ F \to E,\ G \to ACDH \}$

$AE \to AE$ is trivial

As $DH \to C$, $G \to ADH$, $G \to C \Rightarrow \phi$

As, $G \to AD$, $D \to B$, $B \to DC$, $C \to H$, $G \to H \Rightarrow \phi$

~~As $AE \to F \to E$, $AE \to F \equiv A \to E$~~ As $D \to B$, $B \to DC$, $DH \to C \Rightarrow \phi$

$S_c = \{ AE \to F,\ B \to DC,\ D \to B,\ \cancel{DH \to C},\ C \to H,\ F \to E,\ G \to AD \}$

ii) G must appear in any candidate key as it cannot be determined by other attributes.

GE and GF are candidate keys as it is impossible to determine E or F from ABCDGH. Both cover the rest.

iii) Only D is shared between R_a and ~~Rb~~ R_b.

$D^+ = DBCH$

As D covers R_b, this is a lossless decomposition.
Also, all functional dependencies are preserved as all appear in either R_a or R_b.

iv) candidate keys of R_a: GE, GF
candidate keys of R_b: D, B,

~~R_a is not in 3NF due to $AE \to F$~~

$AE \to F$ ✓ (F is prime)
$B \to DC$ ✓ (B is a superkey)
$D \to B$ ✓ (D is a superkey)
~~$DH \to C$ ✓ (D is a superkey)~~
$C \to H$ X R_b is not in 3NF

$F \to E$ X R_a is not in 3NF
$G \to AD$ X R_a is not in 3NF

decomposing R_a on $F \to E$ gives $R_c(ADFG)$ and $R_d(EF)$

~~decomposing R_c and $G \to AD$~~ $G \to AD$ still breaks 3NF of R_c.

decomposing R_c on $G \to AD$ gives $R_e(FG)$ and $R_f(ADG)$

~~of~~ decomposing R_b on $C \to H$ gives $R_g(BCD)$ and $R_h(CH)$

alternative decomposition: $R_d(EF)$, $R_e(FG)$, $R_f(ADG)$, $R_g(BCD)$ $R_h(CH)$

2c) i) $r_1[c_{C2}], r_2[c_{C2}], w_1[c_{C2}], r_1[c_R], w_1[c_R], c_1, r_2[c_B], r_2[c_R],$
$r_2[c_{GB}], c_2$

ii) H_2 and H_4 has this property; as there is only one write operation, lost updates and inconsistent analyses are impossible. There is only one possible conflict, on c_{GB}, so it has to equivalent to one of the two possible serial histories.

iii) $H_c = r_1[c_{C2}], w_1[c_{C2}], r_1[c_R], r_3[c_R], w_1[c_R], w_3[c_R], r_3[c_R] w_3[c_B], c_1, c$

A lost update occurs in H_c ($w_1[c_R]$ is 'lost'), but ~~the~~ H_c is recoverable as no ~~execution can~~ transaction committed before another from which it read.