Question 1

a) **create table** students (sid int, name varchar(40), age int, gpa float, **primary key** (sid));
   create table courses (cid char(7), deptid varchar(10), name varchar(50), **primary key** (cid));
   create table professors (ssn int, name varchar(40), address varchar(60), phone varchar(10), deptid varchar(10), **primary key** (ssn));
   create table teaches (cid char(7), section int, ssn int, **primary key** (cid, section), **foreign key** (cid) **references** courses (cid), **foreign key** (ssn) **references** professors (ssn));
   create table enrollment (sid int, cid char(7), section int, grade varchar(2), **primary key** (ssn, cid), **foreign key** (sid) **references** students (sid), **foreign key** (cid) **references** courses (cid), **foreign key** (cid, section) **references** teaches (cid, section));

b) **Select** name,
   From professors
   Where deptid = ‘cs’;

c) Select e.sid
   From enrollment e
   Join courses c on e.cid = c.cid
   Where c.deptid = ‘cs’;

d) Select p.ssn, p.name
   From professors p
   Where p.deptid = ‘cs’ and p.ssn not in (Select t.ssn
   From teaches t
   Join courses c on t.cid = c.cid
   Where c.deptid = 'CS');

e) Select deptid, count(*) as num_courses
   From courses
   Group by deptid;

f) Select deptid, count(*) as num_courses
   From courses
   Group by deptid
   Having num_courses > 10;

g) Select Distinct s.name
   From students s
   Join enrollment e on s.sid = e.sid
   Join teaches t on e.cid = t.cid and e.section = t.section
   Join professors p on t.ssn = p.ssn
   Where p.name Like 'M%';

Question 2:

a) $C \to D$, $C \to A$, $B \to C$

i) candidate key:

non - prime = ACD

none/LHS	both	RHS
B	C	AD

B^+
BCDA

$B^+ = R$

$\boxed{\text{candidate key} = B}$

ii) Best Normal Form

Since all keys are singleton, it's in 2NF
Check for 3NF, for $C \to D$: D is a non-prime attribute and C is not a superkey so 3NF violation

$\boxed{\text{best normal form} = 2NF}$

iii) BCNF Decomposition

Candidate key: B
BCNF violation: $C \to D$: LHS not superkey
$C \to A$: LHS not superkey

C^+
CD

X = C Y = D Z = AB

(R1) : $C \to D$
(R2) : CAB — $C \to A$, $B \to C$

LHS	both	RHS
B	C	A

B^+
BCA

$\boxed{\text{final decomposition: CD, CA, BC}}$

b) $B \to C$, $D \to A$

i) candidate key:

non - prime = AC

none/LHS	both	RHS
BD		AC

$\frac{BD^+}{BCDA}$ $B^+ : R$ $\boxed{\text{Candidate key} = BD}$

ii) Best Normal Form

$\boxed{R \text{ is only in } 1NF}$

iii) BCNF Decomposition

$B \to C$ and $D \to A$ violate BCNF

$\frac{D^+}{DA}$ $X = D$ $Y = A$ $Z = BC$

(R1) : DA
(R2) : DBC $<$ $B \to C$, $B \to D$

$\boxed{\text{final decomposition: } DA, BC, BD}$

c) $ABC \to D$, $D \to A$
i) candidate key:

LHS	both	RHS
BC	DA	

$\frac{BC^+}{BC}$ $\frac{ABC^+}{ABCD}$ $\frac{BCD^+}{BCDA}$

$\boxed{\text{Candidate key} = ABC, BCD}$

ii) Best Normal Form

Since all attributes are prime, it's in 3NF
$D \to A$ is a BCNF violation

$\boxed{\text{Best Normal Form: } 3NF}$

iii) BCNF Decomposition

If we decompose with R as AD and BCD can't preserve
$ABC \to D$ so there is no BCNF decomposition

d) $AB \to C$, $AB \to D$, $C \to A$, $D \to B$
i) candidate key:

LHS	both	RHS
	ABCD	

$\frac{AB^+}{ABCD}$ $\frac{AC^+}{AC}$ $\frac{AD^+}{ADBC}$ $\frac{BC^+}{BCAD}$ $\frac{BD^+}{BD}$ $\frac{CD^+}{CDBA}$

$\boxed{\text{Candidate Keys: } AB, AD, BC, CD}$

ii) Best Normal Form

3NF all attributes are prime BCNF
violation: $C \to A$, $D \to B$
C and D are not violations

$\boxed{\text{Best normal form: 3NF}}$

iii) BCNF Decomposition

$C \to A$ violates BCNF so R would have to be CA and BCD but functional dependencies $AB \to C$ and $AB \to D$ would not be preserved
R can't be decomposed into BCNF

Question 3:

a) ABC
i) functional dependencies

$\boxed{AB \to C,\ AC \to B,\ B \to C}$

ii) minimal cover

$\frac{A^+}{A}$ $\frac{B^+}{B}$ $\frac{C^+}{C}$

	x^+	
$AB \to C$	AB	✓
$AC \to B$	AC	✓
$BC \to A$	BC	✓

no redundancy exists so the minimal cover is

$\boxed{AB \to C,\ AC \to B,\ BC \to A}$

b) ABCD

i) functional dependencies

$\boxed{AB \to C,\ AC \to B,\ B \to D,\ BC \to A}$

ii) minimal cover

A^+	B^+	C^+	D^+
A	BD	C	D

	X^+	
$AB \to C$	ABD	✓
$AC \to B$	AC	✓
$B \to D$	B	✓
$BC \to A$	BC	✓

no redundancy exists so the minimal cover is

$\boxed{AB \to C,\ AC \to B,\ B \to D,\ BC \to A}$

c) ABCEG

i) functional dependencies

$\boxed{AB \to C,\ AC \to B,\ BC \to A,\ E \to G}$

ii) minimal cover

A^+	B^+	C^+	E^+	G^+
A	B	C	EG	G

	X^+	
$AB \to C$	AB	✓
$AC \to B$	AC	✓
$BC \to A$	BC	✓
$E \to G$	E	✓

no redundancy exists so the minimal cover is

$\boxed{AB \to C,\ AC \to B,\ BC \to A,\ E \to G}$

d) DCEGH

i) functional dependencies

$\boxed{E \to G}$

ii) minimal cover

no redundancy exists so the minimal cover is

$\boxed{E \to G}$

e) ACEH

i) functional dependencies

none of the functional dependencies hold over ACEH

ii) no minimal cover exists