Examine the following records for imaginary students registered in the computer systems technology programme. The last column shows the list of courses and credits in parenthesis each student is currently taking.

Student ID	Student Name	Student Address	Student Postal Code	Student City	Student Phone	Student Email	Student DOB	Course ID
100	Stark	55 Iron Avenue	V9A-3G3	Victoria	250-478-3023	tony@stark.ca	12-May-95	Comp155 (3), Comp183 (3), Comp132 (3), Comp170 (3), Bus140 (2)
200	Parker	#5 - 100 Webb Road	V8E-8Q2	Victoria	250-478-3139	peter@dplanet.ca	01-Jan-98	Comp132 (3), Comp188 (3), Comp1700 (2), Comp155 (3), Bus140 (2)
300	Wayne	3200 Bathearst St	V8E-8W9	Victoria	250-478-9281	bwayne@cave.ca	09-May-94	Comp188 (3),Comp132 (3), Comp171 (3); Comp183(2)-Bus140 (2)
400	Romanova	1928 Black Terrace	V8E-2K3	Victoria	250-474-0019	nat@roman.ca	13-Sep-93	Comp133 (3), Comp155 (3), Comp155 (3), Comp170 (3)

What inefficiencies or problems do you see with this record design approach? (especially with regard to managing the addition, updating, and removing course records for students)

Make a separate relation for each set of related attributes, and give each relation a primary key. Relation **Student** uses Student ID as the primary key and relation **StudentCourse** uses Student ID and Course ID as the primary key. These relations are now in First Normal Form (No repeating groups = all attributes are single valued **and** each row is identified by a unique key, the primary key).

Student ID	Student Name	Student Address	Student Postal Code	Student City	Student Phone	Student Email	Student DOB
100	Stark	55 Iron Avenue	V9A-3G3	Victoria	250-478-3023	tony@stark.ca	12-May-95
200	Parker	#5 - 100 Webb Road	V8E-8Q2	Victoria	250-478-3139	peter@dplanet.ca	01-Jan-98
300	Wayne	3200 Bathearst St	V8E-8W9	Victoria	250-478-9281	bwayne@cave.ca	09-May-94
400	Romanova	1928 Black Terrace	V8E-2K3	Victoria	250-474-0019	nat@roman.ca	13-Sep-93

Student ID	Course ID	Course Name	Course credit
100	Comp 155	Database	3
100	Comp 183	Assembly	3
100	Comp 132	Java	3
100	Comp 170	Operations	3
100	Bus 140	Business	2
200	Comp 132	Java	3
200	Comp 183	Assembly	3
200	Comp 170	Operations	3
...	...	...	...
400	Comp 155	Database	3
400	Comp 170	Operations	3

What inefficiencies or problems do you see with this record design approach?

If an attribute in a relation depends on only *part* of a multi-valued key, remove it to a separate table. In the **StudentCourse** relation, the attributes Course Name and Course Credit are determined by the Course ID (not the combination of Student ID and Course ID). We need to pull out the Course Name and Course Credit into a separate relation called **Course**. The **StudentCourse** relation contains only two attributes: Student ID and Course ID. **StudentCourse** is in first normal form and in second normal form. We added in Teacher name, Office, and Office phone to the **Course** relation, also in first normal form and second normal form.

Student ID	Course ID
100	Comp 155
100	Comp 183
100	Comp 132
100	Comp 170
100	Bus 140
200	Comp 132
200	Comp 183
200	Comp 170
…	…
400	Comp 155
400	Comp 170

Course ID	Course Name	Course credit	Teacher Name	Office	Office Phone
Comp 155	Database	3	Lang	T252	4454
Comp 183	Assembly	3	Bateman	T245	4453
Comp 132	Java	3	Thorndyke	T247	4472
Comp 170	Operations	3	Reimer	T246	4323
Bus 140	Business	2	Miller	C173	5593

What inefficiencies or problems do you see with the design approach?

All attributes in a relation must depend on the primary key for it to be in third normal form. We pull out the attributes Name, Office and Phone Number from the **Course** relation and put them into a separate relation **Teacher** having primary key Teacher Name. Then we create a new relation **CourseTeacher** having primary key Course ID + Teacher Name. Each relation now has no attributes not dependent on the primary key so all three are in third normal form. There are no insertion/update/deletion anomalies and no redundancies.

Course ID	Course Name	Course credit
Comp 155	Database	3
Comp 183	Assembly	3
Comp 132	Java	3
Comp 170	Operations	3
Bus 140	Business	2

Teacher Name	Office	Office Phone
Lang	T252	4454
Bateman	T245	4453
Thorndyke	T247	4472
Reimer	T246	4323
Miller	C173	5593

Course ID	Teacher Name
Comp 155	Lang
Comp 183	Bateman
Comp 132	Thorndyke
Comp 170	Reimer
Bus 140	Miller