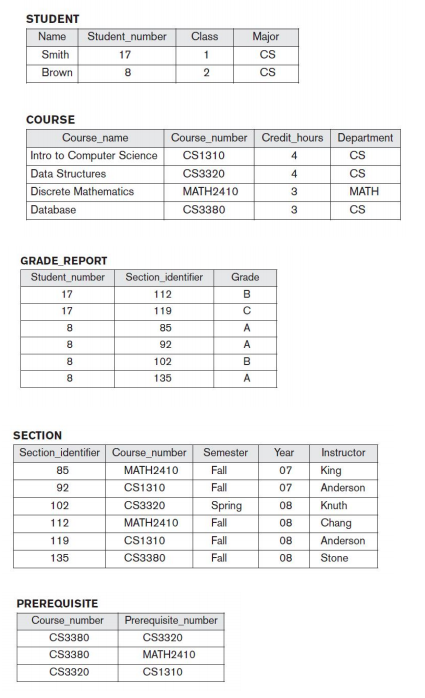
***Consider the database below that stores student and course information. Answer questions 1, 2 and 3 based on this database.***



1. ***What are the referential integrity constraints that should hold on the database above? Write appropriate SQL DDL statements to define the database (Create table statements) Note: To show referential integrity Use the notation R.(A) --> S.(B) to represent a foreign key from the attribute A of R (the referencing relation) to S (the referenced relation). (30 points)***

We have multiple referential integrity constraints that hold for the above table. They are:

1. GRADE\_REPORT.Student\_number -> STUDENT.Student\_number
2. GRADE\_REPORT.Section\_identifier -> SECTION.Section\_identifier
3. SECTION.Course\_number -> COURSE.Course\_number
4. PREREQUISITE.Course\_number -> COURSE.Course\_number
5. PREREQUISITE.Prerequisite\_number -> COURSE.Course\_number

The DDL statements to define the database is:

* Creating STUDENT table –

[CREATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) [TABLE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) STUDENT (

Name [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(30) [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) NULL,

Student\_number [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html) PRIMARY KEY,

Class [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html)(2),

Major [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(20) [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) NULL

)

* Creating COURSE table –

[CREATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) [TABLE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) COURSE (

Course\_name [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(100) [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) NULL,

Course\_number [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(15) PRIMARY KEY,

Credit\_hours [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html)(2),

Department [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(20) [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) NULL

)

* Creating SECTION table –

[CREATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) [TABLE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) SECTION (

Section\_identifier [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html)(4) PRIMARY KEY,

Course\_number [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(15),

Semester ENUM('Fall', 'Spring'),

[Year](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/date-and-time-types.html) YEAR [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) NULL,

Instructor [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(30) [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) NULL,

FOREIGN KEY (Course\_number) REFERENCES COURSE(Course\_number)

ON [DELETE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/delete.html) CASCADE ON [UPDATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/update.html) CASCADE

)

* Creating GRADE\_REPORT table –

[CREATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) [TABLE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) GRADE\_REPORT (

Student\_number [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html),

Section\_identifier [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html)(4),

Grade ENUM('A', 'B', 'C', 'D', 'F'),

PRIMARY KEY (Student\_number, Section\_identifier),

FOREIGN KEY (Student\_number) REFERENCES STUDENT(Student\_number)

ON [DELETE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/delete.html) CASCADE ON [UPDATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/update.html) CASCADE,

FOREIGN KEY(Section\_identifier)REFERENCES SECTION(Section\_identifier)

ON [DELETE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/delete.html) CASCADE ON [UPDATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/update.html) CASCADE

)

* Creating PREREQUISITE table –

[CREATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) [TABLE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) PREREQUISITE (

Course\_number [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(15),

Prerequisite\_number [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(15),

PRIMARY KEY (Course\_number, Prerequisite\_number),

FOREIGN KEY (Course\_number) REFERENCES COURSE(Course\_number)

ON [DELETE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/delete.html) CASCADE ON [UPDATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/update.html) CASCADE,

FOREIGN KEY (Prerequisite\_number)REFERENCES COURSE(Course\_number)

ON [DELETE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/delete.html) CASCADE ON [UPDATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/update.html) CASCADE

)

1. ***Specify the following queries in SQL on the database above. (30 pts.)***
2. ***Retrieve the names of all students majoring in ‘CS’ (computer science).***

[SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) Name

FROM STUDENT

WHERE MAJOR = 'CS'

1. ***Retrieve the names of all courses taught by Professor King in 2007 and 2008***

[SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) C.Course\_name

FROM COURSE AS C, SECTION AS S

WHERE C.Course\_number = S.Course\_number

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) S.Instructor = 'King'

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) (S.Year = '2007' [OR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_or) S.Year = '2008')

1. ***For each section taught by Professor King, retrieve the course number, semester, year, and number of students who took the section.***

[SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) S.Course\_number, S.Semester, S.Year, [COUNT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/group-by-functions.html#function_count)(\*) AS 'Number of Students'

FROM SECTION AS S, GRADE\_REPORT AS G

WHERE S.Section\_identifier = G.Section\_identifier

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) S.Instructor = 'King'

GROUP BY S.Section\_identifier

1. ***Retrieve the name and transcript of each senior student (Class = 2) majoring in CS. A transcript includes course name, course number, credit hours, semester, year, and grade for each course completed by the student.***

[SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) S.Name, C.Course\_name, C.Course\_number, C.Credit\_hours,

G.Grade, SE.Semester, SE.Year

FROM COURSE AS C, STUDENT AS S, SECTION AS SE, GRADE\_REPORT AS G

WHERE C.Course\_number =SE.Course\_number

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) G.Section\_identifier = SE.Section\_identifier

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) G.Student\_number = S.Student\_number

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) S.Class = 2

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html" \l "operator_and" \t "mysql_doc) S.Major = 'CS'

1. ***Retrieve the names and major departments of all straight A students (students who have a grade A in all their courses).***

[SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) S.Name, S.Major

FROM STUDENT AS S, GRADE\_REPORT AS GR

WHERE S.Student\_number = GR.Student\_number

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) GR.Grade [LIKE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-comparison-functions.html#operator_like) 'A'

GROUP BY S.Student\_number

HAVING [COUNT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/group-by-functions.html#function_count)(\*)=([SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) [COUNT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/group-by-functions.html#function_count)(\*)

FROM GRADE\_REPORT AS GR2

WHERE GR2.Student\_number = S.Student\_number

)

1. ***Retrieve the names and major departments of all students who do not have any grade of A in any of their courses.***

[SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) S.Name, S.Major

FROM STUDENT AS S, GRADE\_REPORT AS GR

WHERE S.Student\_number = GR.Student\_number

[AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) GR.Grade [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) [LIKE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-comparison-functions.html#operator_like) 'A'

GROUP BY S.Student\_number

HAVING [COUNT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/group-by-functions.html#function_count)(\*)=([SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) [COUNT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/group-by-functions.html#function_count)(\*)

FROM GRADE\_REPORT AS GR2

WHERE GR2.Student\_number = S.Student\_number

)

1. ***Write SQL update statements to do the following on the database shown above. (20 pints)***

* ***Insert a new student <'Johnson', 25, 1, 'MATH'> in the database.***

[INSERT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/insert.html) INTO STUDENT [VALUES](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/miscellaneous-functions.html#function_values) ('Johnson', 25, 1, 'MATH')

* ***Change the class of student 'Smith' to 2.***

[UPDATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/update.html) STUDENT [SET](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/set.html) Class = 2 WHERE Name [LIKE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-comparison-functions.html#operator_like) 'Smith'

* ***Insert a new course <'Knowledge Engineering','COSC4390', 3,'COSC'>.***

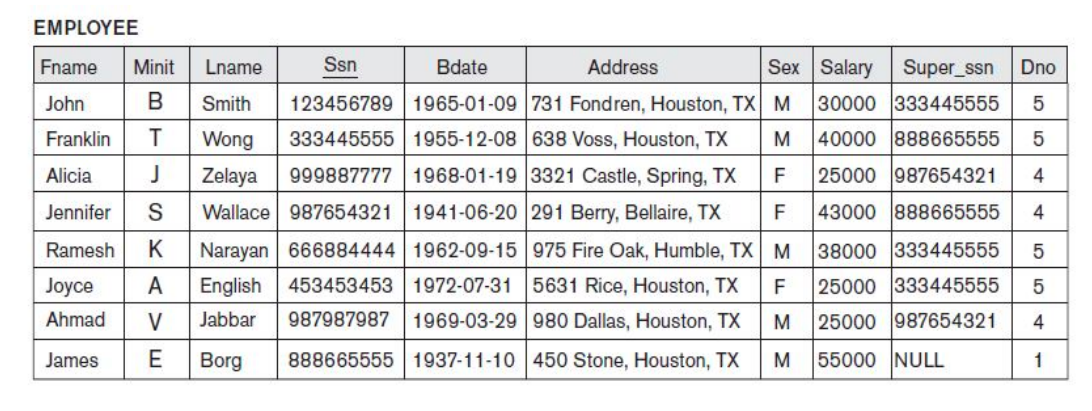
[INSERT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/insert.html) INTO COURSE [VALUES](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/miscellaneous-functions.html#function_values)

('Knowledge Engineering', 'COSC4390', 3, 'COSC')

* ***Delete the record for the student whose name is 'Smith' and student number is 17***

[DELETE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/delete.html) FROM STUDENT WHERE Name [LIKE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-comparison-functions.html#operator_like) 'Smith' [AND](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_and) Student\_number = 17

***Consider the snapshot of Employee table from Company database. Answer Questions 4 & 5 based on this table.***



1. ***Write SQL statement to create a table EMPLOYEE\_BACKUP backup of EMPLOYEE table shown above. (5 pts.)***

[CREATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) [TABLE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/create-table.html) EMPLOYEE\_BACKUP (

Fname [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(30) [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) NULL,

Minit [CHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(1),

Lname [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(30) [NOT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/logical-operators.html#operator_not) NULL,

Ssn [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html)(9) PRIMARY KEY,

Bdate [DATE](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/date-and-time-types.html),

Address [VARCHAR](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/string-types.html)(100),

Sex ENUM('M', 'F'),

Salary [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html)(8),

Super\_ssn [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html)(9) REFERENCES EMPLOYEE\_BACKUP(Ssn),

Dno [INT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/numeric-types.html)(2)

);

[INSERT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/insert.html) INTO EMPLOYEE\_BACKUP [SELECT](http://localhost:8888/phpMyAdmin/url.php?url=https://dev.mysql.com/doc/refman/5.5/en/select.html) \* FROM EMPLOYEE;

1. ***Consider the EMPLOYEE table’s constraint EMPSUPERFK as follows***

***CREATE TABLE EMPLOYEE ( . . . ,***

***Dno INT NOT NULL DEFAULT 1,***

***CONSTRAINT EMPSUPERFK***

***FOREIGN KEY (SUPERSSN) REFERNCES EMPLOYEE(SSN)***

***ON DELETE CASCADE***

***ON UPDATE CASCADE,***

***Answer the following questions:***

* + ***What happens when the following command is run on the database containing Employee table specified above. (5 pts.)***

***DELETE FROM EMPLOYEE WHERE LNAME = ‘Borg’***

Here the definition of the table, reads that there is cascade function to be applied when there is a delete or update for the table Employee. Let us see what happens when we use the above query step wise:

* 1. Since a record with Ssn ‘888665555’ is being deleted, that implies first we need to delete records are linked to Ssn, that is the Super\_ssn with ‘888665555’.
  2. The direct reports of Borg that is Franklin and Jennifer are supposed to be removed. But they also have direct reports of John, Ramesh & Joyce, and Alicia & Ahmad respectively.
  3. Eventually all the records in the Employee table are deleted.
  + ***Is it better to CASCADE or SET NULL in case of EMPSUPERFK constraint ON DELETE? (5 points)***

As we saw above with CASCADE, the complete EMPLOYEE table becomes empty. And as we all know, this is a very crucial data and deletion of such kind could loose a lot of information in the database. In this case, it is better to use SET NULL ON DELETE. Let us take the same query and see what the following:

Since it us the SET NULL, the Super\_ssn of Franklin and Jennifer will be set to NULL and not all records will be deleted except for Borg

1. ***List the data types that are allowed for SQL attributes. (5 pts.)***

SQL Attributes have a huge range of data types for their attributes. They can be classified based on following:

|  |  |  |
| --- | --- | --- |
| *Category* | *Data Type* | *Description* |
| TEXT | CHAR(size) | Text of specific size. Can hold upto 255 characters. |
| VARCHAR(size) | Text of variable size. Can hold upto 255 characters. |
| TINYTEXT | Max. size of 255 characters |
| TEXT | Max. size of 65,535 characters |
| BLOB | Binary Large Objects which holds up 65,535 bytes of data |
| MEDIUMTEXT | Max. size of 16,777,215 characters. |
| MEDIUMBLOB | Binary Large Objects which holds up 16,777,215 bytes of data |
| LONGTEXT | Max. size of 4,294,967,295 characters. |
| LONGBLOB | Binary Large Objects which holds up 4,294,967,295 bytes of data |
| ENUM(a, b, c, ..) | List of possible values. Can hold upto 65,535 values in an ENUM List |
| SET | Array of possible values. Contains upto 64 list items and can store more than one choice. |
| NUMERIC | TINYINT(size) | Can hold integer value from -128 to 127 for signed or 0 to 255 for unsigned. |
| SMALLINT(size) | Can hold integer value from -32,768 to 32,767 for signed or 0 to 65,535 for unsigned. |
| MEDIUMINT(size) | Can hold integer value from -8,388,608 to 8,388607 for signed or 0 to 16,777,215 for unsigned. |
| INT(size) | Can hold integer value from -2,147,483,648 to 2,147,483,647 for signed or 0 to 4,294,967,295 for unsigned. |
| BIGINT(size) | For even more large integers |
| FLOAT(size, d) | Small number with floating decimal point. |
| DOUBLE(size, d) | Large number with floating decimal point. |
| DECIMAL(size, d) | Stored as string, based on the size. |
| BIT | BIT(size) | Stores series of 0s and 1s of specified size |
| BIT VARYING(size) | Stores series of 0s and 1s of variable size |
| BOOLEAN | True | Positive |
| False | Negative |
| NULL | None |
| DATE | DATE() | Format: YYYY-MM-DD |
| DATETIME() | Format: YYYY-MM-DD HH:MI:SS |
| TIMESTAMP() | Format: YYYY-MM-DD HH:MI:SS Here values are stored as number of seconds |
| TIME() | Format: HH:MI:SS |
| YEAR() | Format: YY or YYYY |

References:

* <https://stackoverflow.com/questions/1462497/creating-enum-variable-type-in-mysql>
* <https://stackoverflow.com/questions/2914936/mysql-foreign-key-constraints-cascade-delete>
* <https://www.w3schools.com/sql/default.asp>
* Fundamentals of Database Systems, Sixth Edition, by Elmasri/Navathe