**Step 1 — Relational database schema (3NF) + SQL DDL**

**ASCII ER diagram (3NF)**

sql

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| users |1 n | items |1 1 |auctions|

|---------|--------|-----------|--------|--------|

| user\_id | | item\_id | |auction\_id

| email | | seller\_id | |item\_id (UNIQUE)

| pw\_salt | | title | |start\_time

| pw\_hash | | descr | |end\_time

| created | | start\_prc | |closed (flag)

+---------+ | created | +--------+

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| bids |

|-----------|

| bid\_id |

| auction\_id|

| bidder\_id |

| amount |

| created |

+-----------+

+-----------+

| sessions |

|-----------|

| session\_id|

| user\_id |

| created |

| expires |

+-----------+

* **users**: one row per account (email unique).
* **items**: one row per item for sale; owned by a seller.
* **auctions**: one row per item auction; fixed 7 days window; closed acts as a latch (you can also derive by NOW()>end\_time).
* **bids**: many bids per auction from many users.
* **sessions**: cookie session tokens per login.

No repeating groups, no partial or transitive dependencies → **3NF**.

**SQL DDL (run in phpMyAdmin or mysql client)**

sql

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CREATE DATABASE IF NOT EXISTS auctiondb

CHARACTER SET utf8mb4 COLLATE utf8mb4\_unicode\_ci;

USE auctiondb;

-- USERS

CREATE TABLE users (

user\_id INT AUTO\_INCREMENT PRIMARY KEY,

email VARCHAR(255) NOT NULL UNIQUE,

password\_salt CHAR(32) NOT NULL, -- hex salt

password\_hash CHAR(64) NOT NULL, -- hex SHA-256(salt || password)

created\_at DATETIME NOT NULL DEFAULT CURRENT\_TIMESTAMP

) ENGINE=InnoDB;

-- SESSIONS

CREATE TABLE sessions (

session\_id CHAR(64) PRIMARY KEY, -- hex token

user\_id INT NOT NULL,

created\_at DATETIME NOT NULL DEFAULT CURRENT\_TIMESTAMP,

expires\_at DATETIME NOT NULL,

CONSTRAINT fk\_sessions\_user

FOREIGN KEY (user\_id) REFERENCES users(user\_id)

ON DELETE CASCADE,

INDEX (user\_id),

INDEX (expires\_at)

) ENGINE=InnoDB;

-- ITEMS

CREATE TABLE items (

item\_id INT AUTO\_INCREMENT PRIMARY KEY,

seller\_id INT NOT NULL,

title VARCHAR(150) NOT NULL,

description TEXT NOT NULL,

starting\_price DECIMAL(10,2) NOT NULL CHECK (starting\_price >= 0),

created\_at DATETIME NOT NULL DEFAULT CURRENT\_TIMESTAMP,

CONSTRAINT fk\_items\_seller

FOREIGN KEY (seller\_id) REFERENCES users(user\_id)

ON DELETE CASCADE,

INDEX (seller\_id)

) ENGINE=InnoDB;

-- AUCTIONS (one active/finished auction per item)

CREATE TABLE auctions (

auction\_id INT AUTO\_INCREMENT PRIMARY KEY,

item\_id INT NOT NULL UNIQUE,

start\_time DATETIME NOT NULL,

end\_time DATETIME NOT NULL,

closed TINYINT(1) NOT NULL DEFAULT 0,

CONSTRAINT fk\_auctions\_item

FOREIGN KEY (item\_id) REFERENCES items(item\_id)

ON DELETE CASCADE,

INDEX (end\_time),

INDEX (start\_time)

) ENGINE=InnoDB;

-- BIDS (max-bid style simplified: amount is the user's current max bid)

CREATE TABLE bids (

bid\_id INT AUTO\_INCREMENT PRIMARY KEY,

auction\_id INT NOT NULL,

bidder\_id INT NOT NULL,

amount DECIMAL(10,2) NOT NULL CHECK (amount >= 0),

created\_at DATETIME NOT NULL DEFAULT CURRENT\_TIMESTAMP,

CONSTRAINT fk\_bids\_auction

FOREIGN KEY (auction\_id) REFERENCES auctions(auction\_id)

ON DELETE CASCADE,

CONSTRAINT fk\_bids\_bidder

FOREIGN KEY (bidder\_id) REFERENCES users(user\_id)

ON DELETE CASCADE,

INDEX (auction\_id),

INDEX (bidder\_id),

INDEX (auction\_id, amount)

) ENGINE=InnoDB;